FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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December, 1955 Volume 9, Number 12

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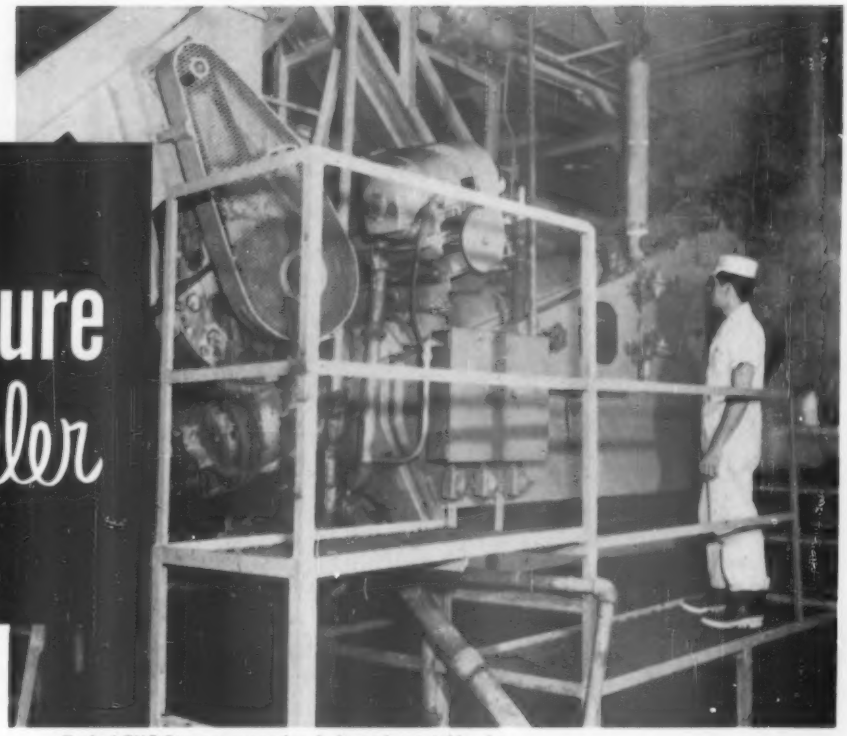

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The Vital Story of VITAMIN C

by Science Writer

What does vitamin C do for human beings?

Medical research shows that it is essential in maintaining healthy bony tissue and for the formation of collagen which is the main supportive protein of skin, tendon, bone, cartilage and connective tissue. It is needed for vascular function and tissue respiration and in promoting the healing of wounds. In lactating women it has great importance in providing the infant with a sufficient amount of ascorbic acid to prevent scurvy, a disease to which very young babies are susceptible.

Much evidence is available in medical reports to show that a lack of this vital nutritive element can result in impaired health. And in those cases of frank scurvy which still occur, ascorbic acid is the specific medication.

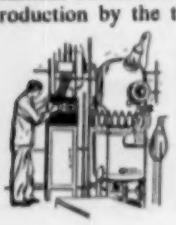
History. The history of vitamin C is fascinating. Scurvy, known for centuries, was once the most prevalent disease in Europe. It afflicted the Crusaders, decimated the crews of voyagers and armies, and plagued the colonists of the New World. In the 18th Century the antiscorbutic value of fresh vegetables and citrus fruits was recognized.

Isolation. It was not until 1918-25 that almost pure ascorbic acid was concentrated from the lemon by Zilva and its important properties and molecular composition established. In 1927 he concluded that this so-called "reducing factor" and the antiscorbutic principle were closely related. In 1928, Szent-Györgyi, who started investigations in 1921, isolated a strong reducing compound from adrenal glands, oranges, and cabbage and termed it "hexuronic acid."

Chemistry. The "reducing factor," "hexuronic acid," and vitamin C were all identified as the same in 1932 by various groups of workers. This was one year after C. G. King, by methods of organic chemistry and experimental physiology, established the chemical identification of vitamin C, thus fulfilling Budd's prediction of 90 years earlier that the antiscorbutic property of certain foods would ultimately be discovered to be a definite substance.

Synthesis. In 1933 Reichstein and his colleagues in Switzerland successfully synthesized ascorbic acid. Almost simultaneously in England Haworth and associates accomplished the same. The Reichstein synthesis formed the basis for large scale commercial production by the world-famous firm of Hoffmann-La Roche.

Production. Following these discoveries came the establishment of manufacturing operations so that today daily production by the tons is the rule. The figures are really staggering. The amount produced weekly in the U. S. A. averages over 15 tons, equivalent to that contained in over 200 million oranges. It is remarkable that ascorbic acid can be produced synthetically and sold for only about $16. per kilogram. One kilo is sufficient to supply 92 people for one year with the minimum daily requirements set by the U. S. Food and Drug Administration.



Vitamin C made by the Roche process is identical chemically and in biological activity with Nature's own product. Because vitamins can be manufactured at a much lower cost than if they were extracted from natural sources they are widely used in dietary supplements and pharmaceuticals. In fact, "New and Non-official Remedies," a publication of the American Medical Association for use by physicians states: "All pure ascorbic acid used in pharmaceutical products is prepared synthetically."

Ascorbic acid is present in many foods. Nature supplies some with lavish amounts and stints on others. In fact, wide variations* have been found in the vitamin C content in varieties of the same fruit.

Deficiencies. Many surveys have shown widespread vitamin C deficiencies in the population. Physicians may call these subclinical, but they are deficiencies nevertheless.

Because of these situations—natural variation and widespread deficiencies—diet experts believe that it is desirable and in the public interest to standardize the vitamin C content of processed fruit and vegetable juices by the addition of enough pure crystalline ascorbic acid to make them consistently dependable sources of this necessary food element. Some of these juices are: tomato, grape, orange, grapefruit, pineapple and apple.

Requirements. The U. S. Food & Drug Administration has set 30 milligrams as the adult minimum daily requirement of ascorbic acid. This daily intake is just about sufficient to prevent recognizable signs of vitamin C deficiencies although a subclinical or an unrecognized deficiency may exist. In view of this, the National Research Council has established 75 milligrams as the recommended daily male adult allowance and 70 mg. daily for female adults, which levels are supported by many controlled nutrition studies. However, the N. R. C. recommends 90 mg. daily for boys between 13 and 15, 100 mg. daily for boys between 16 and 20, and 150 mg. daily for lactating women.

This article is published in the interests of pharmaceutical manufacturers and food processors who make their good products better with essential, health-giving vitamin C. Reprints are freely available. Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.

*The table shows minimum and maximum levels of ascorbic acid in commercially canned juices. All figures are in milligrams per 100 grams of juice. Data from U. S. Department of Agriculture.

	Min.	*Max.*
Apple juice	0.2	3.6
Grape juice	0.0	4.7
Grapefruit juice	10.0	49.0
Orange juice	9.7	70.0
Pineapple juice	5.4	18.0
Tomato Juice	2.5	32.0

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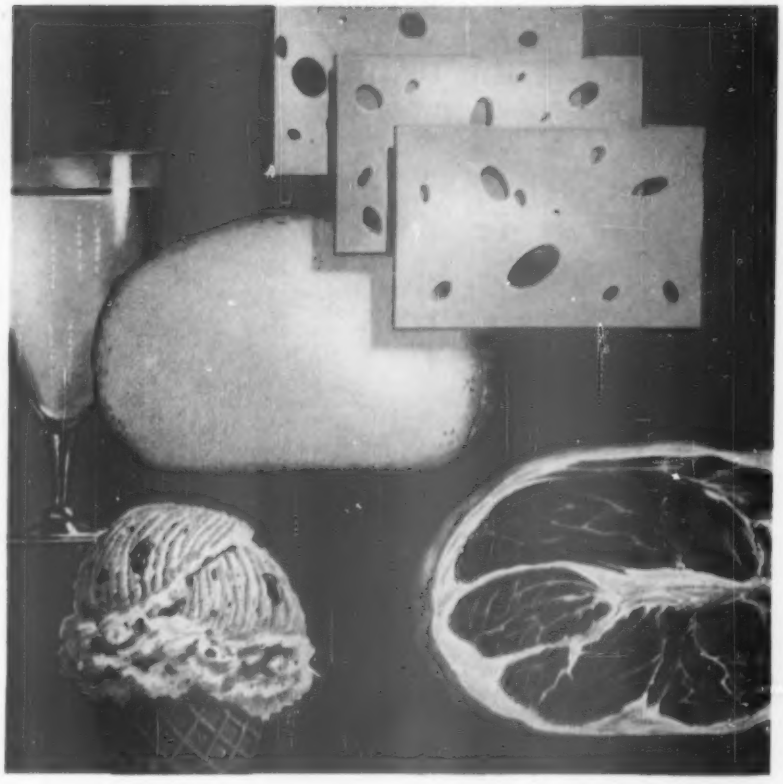

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Food Industry Topics

Annual Meeting Bulletin Board

Final Call for Titles of Papers for Presentation at St. Louis, June 10-14, 1956

Food preservation—canning, freezing, dehydrating, irradiating, curing, fermenting, and smoking—will be put under scrutiny in St. Louis in June. New products, new techniques, new equipment, and new food machinery will also be described and analyzed.

Deadline for Titles is January 1, 1956. Titles of papers proposed for presentation at St. Louis are coming in to the chairman of the Program Committee, Dr. R. J. Sumner, in good style but for those who have not yet registered their titles, a reminder—the deadline for titles is January 1, 1956. Address Dr. R. J. Sumner, Care of Central Research Department, Anheuser-Busch, Inc., St. Louis 18, Missouri.

Deadline for Abstracts is February 1, 1956. Abstracts of annual meeting papers must be in the hands of the Program Committee, Dr. R. J. Sumner, Chairman, by February 1, 1956. A standardized form will be provided for all prospective authors.

Heart of down-town St. Louis, site of 1956 meeting of IFT

Features of the Technical Program. Plans for a general symposium honoring the fiftieth anniversary of the Food and Drug Act are well along. Shaping up is a session on food research and development and its application to Army, Navy and Air Force requirements. Great strides have been made in adapting feeding systems to an age of jet planes and nuclear weapons. Colonel J. D. Peterman, Commandant, Quartermaster Food and Container Institute for the Armed Forces, will chairman the session.

Facilities will be available at the St. Louis meeting for informal discussion groups, open to all members. Anyone wishing to organize such a group should advise Dr. Sumner at the earliest possible moment so that rooms and time can be scheduled.

Program progress. The first report on the progress of the technical program of the 1956 meeting has come in from Program Chairman, Dr. R. J. Sumner. A number of papers have already been received from the fields of food engineering, frozen foods, irradiation, and fruits and vegetables. The symposium in commemoration of the 50th anniversary of the Food and Drug Law is being rounded out as a result of conferences held this fall. Mr. Howard A. Prentice, Vice President, Corn Industries Research Foundation, 1001 Connecticut Avenue, N.W., Washington, D. C. will preside. This session promises to be an outstanding event in the history of deliberations on this famous law and will be particularly pertinent in view of the interest in current proposed legislation. Another session recently added to the program is the one to be devoted to developments in Army, Navy, and Air Force research relating to foods, a revival of a type of session which was formerly a standard part of IFT annual meetings. Colonel J. D. Peterman, Commandant of the Quartermaster Food and Container Institute for the Armed Forces, will preside at this session. Curiosity as to the advances in radiation sterilization will be appeased in the session entitled "radiation," Dr. Bruce Morgan, chairman, and "sensory testing" will be discussed and analyzed under the chairmanship of Dr. Ernest E. Lockhart, Scientific Director, the Coffee Brewing Institute, Inc. The complete roster of session chairmen and the sessions over which they will preside follows:

1956 IFT Session Chairmen

PACKAGING
Dr. Lucius Elder, General Foods Corporation, Hoboken, New Jersey.

CEREALS
Dr. Robert A. Larsen, Associate Manager, Dept. of Scientific Research and Technical Development, Pillsbury Mills, Inc., Minneapolis 2, Minnesota.

MEAT
Dr. W. M. Urbain, Associate Director of Research, Swift & Company, Union Stock Yards, Chicago 9, Illinois.

FRUITS AND VEGETABLES
Dr. D. K. Tressler, Scientific Director, Quartermaster Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Illinois.

FROZEN FOODS
Mr. H. P. Schmitt, National Association of Frozen Food Packers, 1415 K Street, N. W., Washington 5, D. C.

NEW PRODUCTS AND PRACTICES
Dr. Domenic DeFelice, Research Manager, Associated Products Division, General Foods Corporation, White Plains, New York.

SENSORY TESTING
Dr. Ernest E. Lockhart, Scientific Director, The Coffee Brewing Institute, Inc., 551 Fifth Avenue, New York 17, N. Y.

FOOD ENGINEERING
Dr. I. J. Hutchings, Manager of Food Research, H. J. Heinz Company, Pittsburgh 30, Pa.

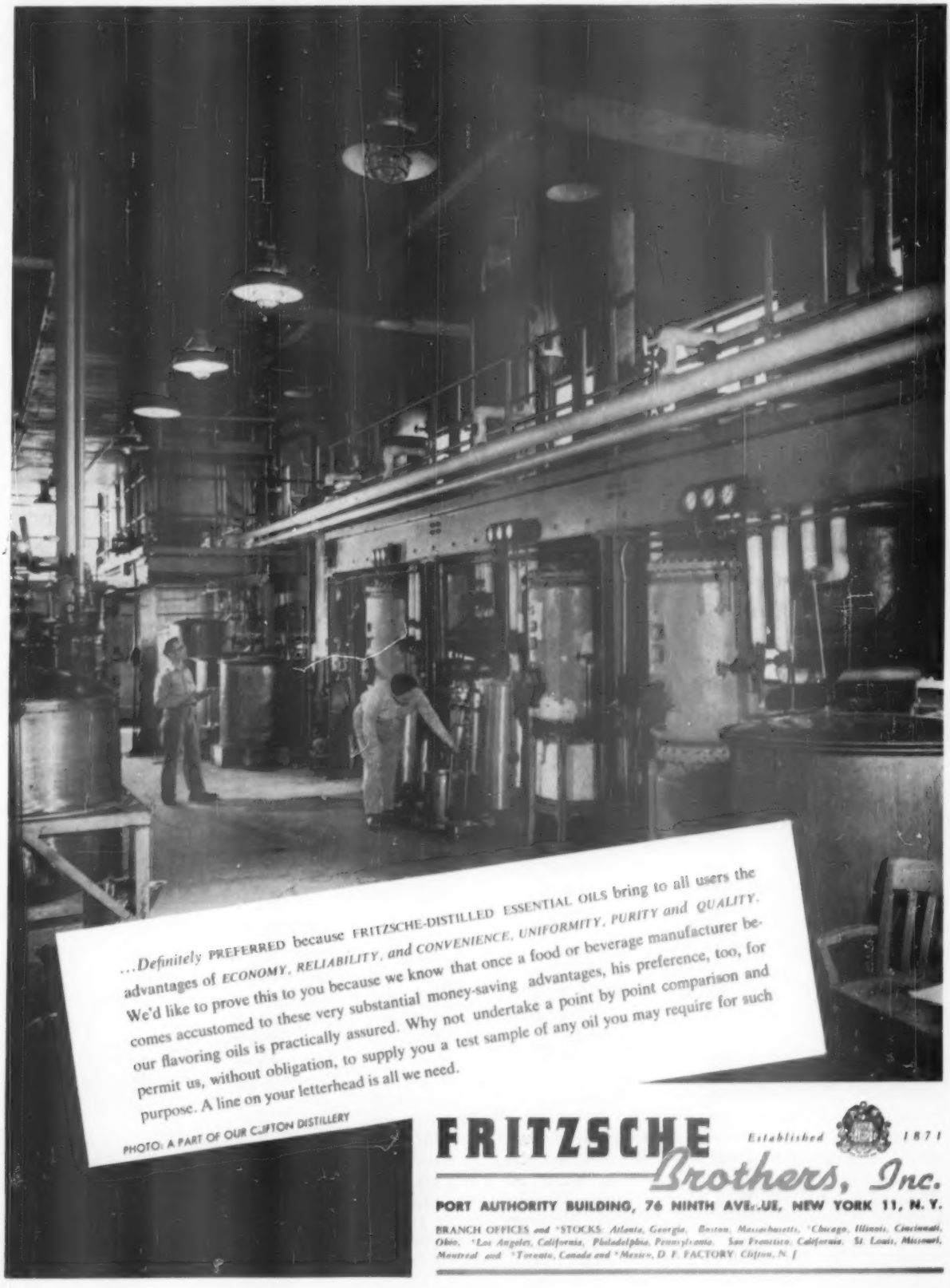
CITRUS PRODUCTS
Mr. Clarence W. DuBois, Minute Maid Corporation, Plymouth, Florida.

DEHYDRATION
Mr. John H. Nair, Assistant Director of Research, Thomas J. Lipton, Inc., Hoboken, N. J.

IRRADIATION
Dr. Bruce H. Morgan, Quartermaster Food and Container

(Continued on page 6)

PREFERRED...



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ANNUAL MEETING BULLETIN BOARD

(Continued from page 4)

Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Illinois.

CANNING

Dr. George W. Beach, Manager of General Labs., Libby, McNeil & Libby, Blue Island, Illinois.

APPLICATION OF FOOD RESEARCH TO MEET ARMED FORCES' REQUIREMENTS

Col. John D. Peterman, Commandant, Quartermaster Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Illinois.

GENERAL RESEARCH PAPERS

Dr. D. E. Brady, College of Agriculture, Department of Animal Husbandry, University of Missouri, Columbia, Missouri.

SYMPOSIUM IN COMMEMORATION OF THE 50TH ANNIVERSARY OF THE FOOD AND DRUG LAW

Mr. Howard A. Prentice, Vice President, Corn Industries Research Foundation, 1001 Conn. Ave., N. W., Washington 6, D. C.

FERMENTATION

To be announced later.

MICROBIOLOGY

To be announced later.

It is planned to arrange an information discussion session on Chemicals in Foods.

Regional Section News

DIXIE SECTION

The Section met for its first fall meeting at Emory University on September 30 to hear Professor Thomas W. Christopher, Associate Dean of the Lamar School of Law, Emory University, discuss the proposed model State Food, Drug, and Cosmetic Act. Dean Christopher pointed out that approximately one-half of the states in the Union have Food and Drug Acts similar to the 1938 Federal Food, Drug, and Cosmetic Act and approximately one-half of the states have Acts similar to the Food and Drug Act of 1906. He pointed out the superiority of the 1938 Act compared with the 1906 Act, and discussed arguments pro and con as to the advantages of having relatively uniform Food, Drug, and Cosmetic Acts in all the states. Professor Christopher suggested that state food and drug acts should also include a provision similar to the one in the federal Act whereby standards for foods could be formulated and promulgated. There were approximately fifty-five members and guests in attendance at the meeting. Dr. J. G. Woodroof, Chairman of the Section, announced the membership of the Section committees for the year.

The Section met jointly with the Georgia Section of the American Chemical Society on October 20 to hear Dr. Ernest Guenther, Vice President in charge of research, Fritzsche Brothers, Inc. speak on the essential oil industry. Dr. Guenther showed an interesting movie in color to illustrate the production and processing of various plant materials for the extraction of essential oils. The production of such oils as rose, lavender, geranium, eucalyptus, spike, and lemon in France, Algeria, other parts of Africa, Austria, Spain, Switzerland and Italy were shown. Approximately 125 members and guests of the A. C. S. and IFT Regional Sections saw Dr. Guenther's interesting movie and enjoyed his comments and personal observation regarding the essential oil industry.

PHILADELPHIA SECTION

The section met on October 4, 1955, at Drexel Institute. The attendance was 62.

Mr. Mahle, Chairman, reported that the suggestions prepared by the New York and Philadelphia sections concerning changes in the constitution were not accepted by the National Council.

The following committees were announced:

House Chairman—Elizabeth Mellor, Keith West
Membership Committee—Robert Hughes
Educational Committee—Joseph Harrison, Richard Mullan
Auditing Committee—Carl Pratt, Everard Webster

The speaker of the evening was Dr. Brooks A. Brice of The Eastern Regional Research Laboratory of the U. S. Department of Agriculture. Dr. Brice delivered an enlightening talk on "The Measurement and Specification of Color." He explained how four basic sciences: physics, physiology, chemistry, and psychology are required to fully understand color. With the aid of a series of vivid colored slides. Dr. Brice demonstrated how many thousands of perceptively different colors may be made by the mixing of the three primary colors. It was extremely interesting to note when the primary colors are reduced to numerical terms and expressed graphically any variety of color can be prepared by selecting the appropriate percentages of the primaries. With this method, Dr. Brice explained that colors can be designated by few numbers and thus was established a universal standard of every possible color. He emphasized the need of permanent standard colors in a variety of food products.

NORTHERN CALIFORNIA SECTION

Dr. J. Larry Heid, Editor, *Western Canner & Packer*, addressed the Section's October 13th meeting on "Frozen Citrus Concentrates Industry." The meeting was held in Spenger's Restaurant, Berkeley. Dr. Glenn Sorber was guest of honor at this meeting when the Section members helped him to celebrate his retirement from the administrative staff of USDA's Western Utilization Research Branch in Albany.

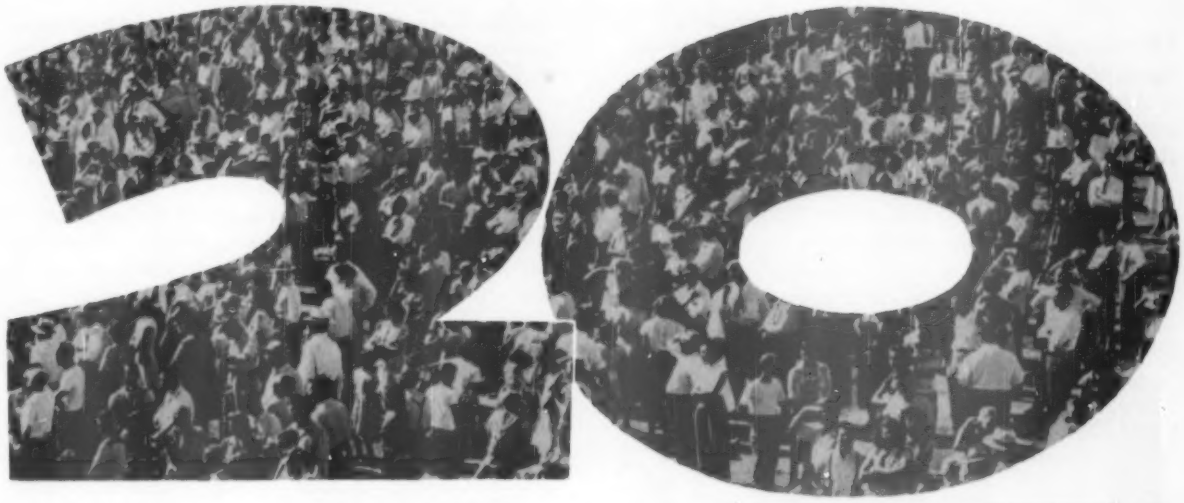
CHICAGO SECTION

October Meeting at the University of Illinois. The festivities of the day began at 10:00 A.M. with tours of the Animal Science, Food Technology and Dairy Science Departments. The Food Technology Club is to be complimented on the smoothness with which the tours were handled. By the tone and number of questions "thrown" to the tour guides, the visitors were evidently quite interested in the laboratories and equipment.

At noon luncheon was served at the University Armory under the stern brow of a Sherman tank. Dr. Reid T. Milner, Head of the Department of Food Technology, presided over a short meeting, introducing Dr. L. B. Howard. Dr. John M. Jackson expressed his

(Continued on page 8)

more than



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B

REGIONAL SECTION NEWS

(Continued from page 6)

appreciation to Dr. Milner, Dr. Howard, and the members of the Food Technology Club at the University for their efforts in making the meeting possible.

Dr. S. E. Hartsell, Chairman of the Indiana Section, and Mr. W. O. Edward, Vice-Chairman of the St. Louis Section were introduced and the visiting members of those sections were welcomed.

Dr. Milner gave a short resume of the organization and enrollment of the Department of Food Technology and closed his remarks with a brief statement on the University's plans for the future.

Following adjournment of the meeting, members and guests trekked across the campus to the stadium to shout and cheer for the Illini vs. Minnesota.

GREAT LAKES SECTION

The Section held its fall and annual meeting at Michigan State University, East Lansing, on Friday, October 28. The morning was devoted to a tour of the campus and a Director's Luncheon was held in the Union Building. The afternoon technical session was opened by Dr. Lloyd M. Turk, Director of the Agricultural Experiment Station. Two papers were given:

"The Nature of the Response in Sensory Evaluation of Foods," by Dr. Howard Schutz, Acceptance Division, Food Laboratories, Quartermaster Food and Container Institute, Chicago Quartermaster Depot, Chicago, Illinois.

"Statistical Methods for Evaluating Laboratory Tests," by Dr. John J. Halsey, Manager Quality Testing and Inspection, Chemical Division, Merck & Co., Rahway, New Jersey.

The dinner meeting was held in the Emerald Room, Hotel Roosevelt, Lansing, Mich., and Dr. L. E. Clifcorn, IFT President was guest speaker. His topic: "The Problems of Chemicals in Foods."

NORTHEAST SECTION

The opening meeting of the Northeast Section for the 1955-56 season was well attended—84 members and guests. It was held at the University Room, Smith House, Cambridge, Mass. on Thursday evening, October 6.

The featured speaker was Dr. Henry B. Hass, President of the Sugar Research Foundation, who presented a paper on "Recent Developments in Sucro Chemistry." Dr. Hass has done notable work in organic chemistry ever since his college days at Ohio State, where he received his Ph.D. in 1925.

Dr. Hass revealed that the sugar molecule has invaded the field of synthetic detergents. In conjunction with Foster D. Snell, Inc. he started a project to investigate the different ways of combining sugar with lipophilic substances. A hydrophilic-lipophilic combination is the basis of non-ionic synthetic detergents, where ethylene oxide is linked with fat soluble molecules of suitable size. Substituting sucrose for ethylene oxide, it was found that an alcoholysis reaction between it and

(Continued on page 10)

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REGIONAL SECTION NEWS

(Continued from page 8)

fatty acid esters yields a new family of efficient and potentially inexpensive detergents and emulsifying agents. They are further colorless, odorless, nearly tasteless, non-irritating, and non-toxic.

Applications in the food industry appear to be far reaching. Investigations are currently being carried on at the Georgetown University Medical School into the possible application of these compounds for the treatment of osteoporosis, a condition of bone fragility in old people.

NOVEMBER MEETING

The November meeting of the Northeast Section was highlighted by a talk by Mr. Daniel C. McCoy of the Frigidaire Corporation of Dayton, Ohio. Mr. McCoy presented an interesting and well illustrated talk on the subject of "Foods and Their Relation to Refrigeration." A large audience was present.

One of the new features of the Northeast Section is the newsletter called "The Nor'easter," which comes out each month along with the notice of the meeting.

Plans are being made by the Section for their annual Ladies' Night to be held on December 1, 1955. Dean Prescott will present the first version of his "Origin and History of IFT" at that time.

The Section is now preparing an up-to-date listing of all paid-up N. E. Section members by name and company affiliation which will be attractively prepared and conveniently cross-indexed as well.

MARYLAND SECTION

The Section's very-well-attended October meeting was held in Baltimore on October 14th at the Hotel Stafford, where Dr. Amihud Kramer addressed us on "Food Production in Israel." Dr. Kramer, a past chairman of Maryland Section and long-time member of the Department of Horticulture, University of Maryland, was assigned to Israel as a member of the Foreign Operations Mission of the U. S. Government.

His analysis of the food production situation in Israel was very interesting, due to his clever coverage of the subject by color transparencies which he showed as he talked. Of particular interest too was the graphic description of the effect of climate and geography on the presence, as well as type, of crops that were raised.

Nature has provided Israel with the River Jordan-Sea of Galilee-Dead Sea water system, flowing from north to south. Most crops that are raised depend upon irrigation or naturally occurring sub-surface moisture which arises from this stream. Crops raised here include a very high-grade peanut and fine citrus fruit, both of which find a ready European market. Dairy products, especially cheese, are plentiful, but the sanitation is not up to our standards. In fact, Dr. Kramer feels that food industrial conditions are twenty-five years behind ours. Poultry production is progressing, especially in the field of broilers. Some eggs have found an export outlet.

The grain picture is improving, especially in the Dead Sea latitudes, with several very modern grain elevators now standing. Because goats are no longer permitted to overgraze valuable pasture land, and once-native grass is being replanted from Australia, the erosion is being overcome; thus cattle-raising should develop in a few years. Then beef importation from Eritrea and Ethiopia may be curtailed in favor of domestic meat.

The can manufacturing industry is poorly developed, especially as regards lacquering. Glass, on the other hand, is easy to produce and should come into the foreground here. Labor is plentiful, due to slack periods in each industry; so mechanization is slow to develop.

Dr. Kramer discussed the country from North to South, showing how the climate and latitude affect each area and its crops. He felt that although much has been accomplished in the past few years, very much "know-how" and equipment are needed to change conditions significantly.

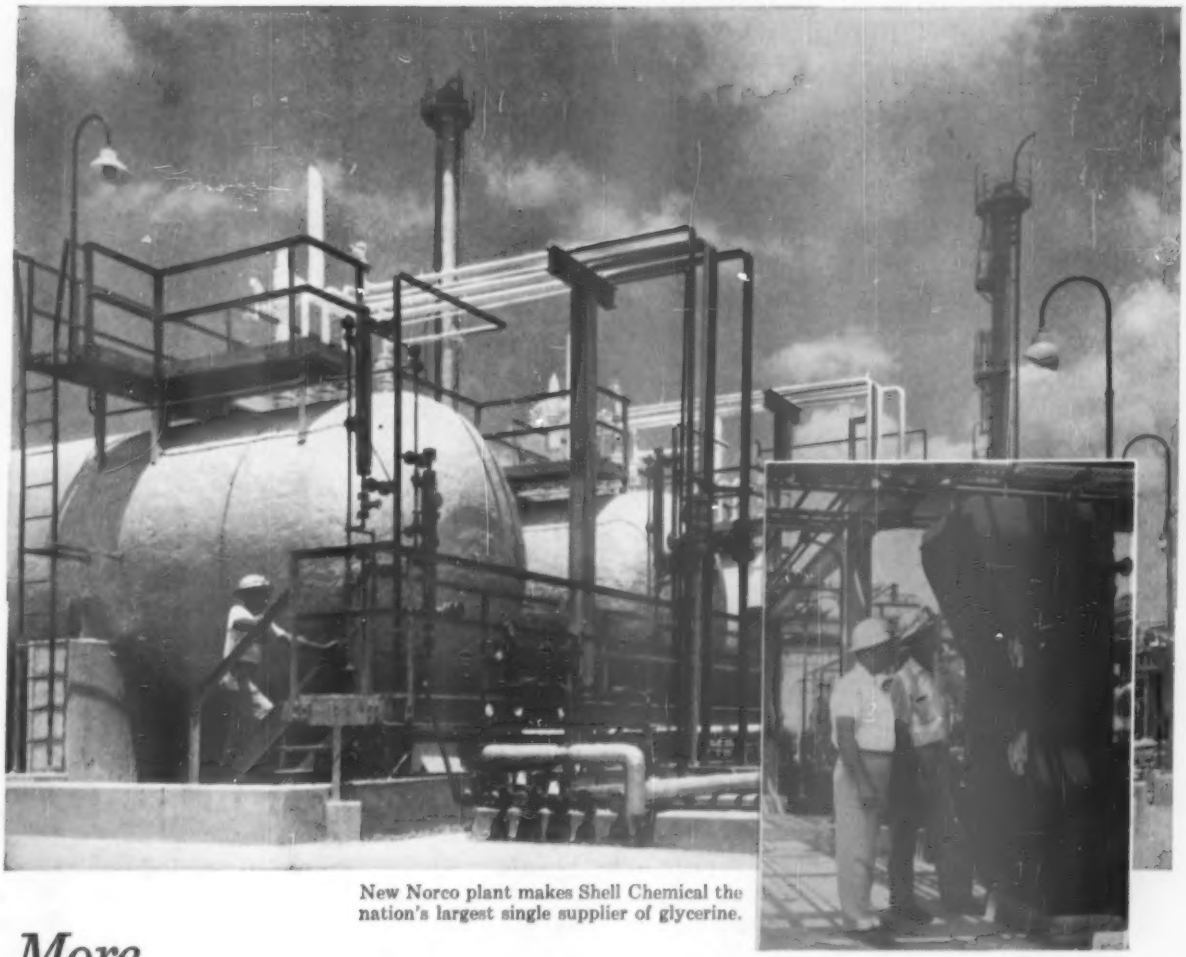
PERSONNEL

Dr. Wolfgang Huber, chemical consultant, has moved from Broooklyn, New York, to 68 Bret Harte Terrace, San Francisco, California. As formerly he will concentrate on applied radiation, food chemistry, and organic fine chemicals. Uses of atomic radiation in industry, a phase of the Atoms-for-Peace movement, will continue to be an important aspect of Dr. Huber's activities.

Dr. Roy E. Morse, formerly research director for William J. Stange Co. in Chicago, has joined Rutgers University at New Brunswick, New Jersey, as professor in the department of food technology, headed by Dr. Walter Maclinn. His work will consist largely of teaching coupled with research. Dr. Morse, well known for his work in meat and other food preservation, brings to his new field of endeavor the industrial point of view and long industrial experience. It is being widely recognized that filling the need for teachers at the college level is prerequisite to relieving the shortage of technical manpower in the food industries.

Mr. Eugene H. Allen, Jr., a charter member of the Institute of Food Technologists and long affiliated with the Great Atlantic and Pacific Tea Company (Quaker Maid), New York City, has been assigned a post on the U. S. Mission to Italy where he will work with and aid the National Food Production Center of that country as food technologist and consultant. With other American chemists and food processing engineers Mr. Allen will leave New York City in mid-December for his new post. His mailing address will be:

Mr. Eugene H. Allen, Jr.
Food Technologist
U.S.O.M. to Italy
U. S. Embassy
Rome, Italy



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Substantial Program in Prospect for First International Symposium on Food Physics

The first international symposium on "Food Physics: The Application of Physical Principles in Food Research and Production," sponsored jointly by Southwest Research Institute and the Institute of Food Technologists, and to be held in San Antonio, March 15-16, at the Plaza Hotel, is enlisting the interest of noted research organizations and the leaders in this phase of food science. Technical papers by eleven authorities in the physical sciences have already been accepted.

Purpose of the symposium is to show benefits that have come to the food industry through the application of physical techniques and to discuss new developments which can be utilized to further advantage. Information of definite importance to the food industries now and in the future will come out of this two-day conference.

The contribution of physics to measurement and control will be brought out and the papers and discussion should help structure this rapidly developing field. Reports on methods used in measuring physical properties of dough, crystallization in foods, and the measurement of quality in agricultural commodities will be presented. Two promising new methods will be described—nuclear magnetic resonance spectroscopy (a method for the rapid, non-destructive analysis of liquids and solids) and vapor chromatography (a technique for the separation and identification of volatile materials in foods). How the automatic control of food processes by automation depends on measuring instruments based on physical principles will also be discussed.

New methods of preserving and processing foods to be reviewed in the symposium include sterilization with atomic radiation, electrostatic smoking, radio-frequency heating, and processing with ultrasonics.

Speakers scheduled to date include Dr. P. M. Erlandson, Director of Physics Research, Continental Can Company; Dr. D. M. Doty, Assistant Director, Research and Education, American Meat Institute Foundation; Mr. R. J. Beeley, Senior Engineer, Atomics International (a division of North American Aviation, Inc.); Mr. T. M. Shaw, Senior Research Physicist, Southwest Research Institute; Dr. I. Hlynka, Chemist, Grain Research Laboratory, Winnipeg; Dr. K. P. Dimick, Chemist, Western Utilization Research Branch, U. S. Department of Agriculture; Professor A. Cornwell Shuman, Purdue University; and Mr. K. H. Norris, Agricultural Engineer, Marketing Research Division, U. S. Department of Agriculture.

The technical papers will be followed by a round-table discussion in which all speakers will participate. Activities for the San Antonio meeting include a banquet at the Plaza Hotel with a top executive of one of the major food processing companies as featured speaker. A tour of Southwest Research Institute will conclude the meeting.

For further information and registration details, write Mr. C. W. Smith, General Chairman, Food Physics Symposium, Southwest Research Institute, San Antonio, Texas.

Selected Abstracts*

ANALYTICAL METHODS

The micro and semimicro determination of alkoxyl groups.

BELCHER, R., FILDES, J. E., AND NUTTEN, A. J. *Anal. Chim. Acta, 13,* 16-22 (1955).

An examn. has been made of the sources of error assocd. with the detn. of alkoxyl groups. Several features of other methods have been incorporated in a simple app., and a modified procedure is presented for both the micro and semimicro detn. of methoxyl and ethoxyl groups.

Paper chromatographic determination of antioxidants.

GANDER, K. F. *Fette u. Seifen, 57,* 423-5 (1955).

A relatively simple paper chromatographic method enables the detn. of 2, in some cases even 3 of the recommended antioxidants in solns. and alc. exts. of lard or margarine fat. They are characterized by the R_f-values obtained in applying various solvents and by differences in the way of coloring with $AgNO_3$ and dichloroquinonchlorimide-soln.

Routine exchange capacity determinations of ion exchange resins.

FISHER, S., AND KUNIN, R. *Anal. Chem., 27,* 1191-4 (1955).

Simple, rapid methods for the detn. of both anion and cation exchange capacities of ion exchange polymers have been devised using equipment generally available in all laboratories. The effect of the initial ionic form of the resin on the measured capacity has also been detd.

A photometric method for estimating the lipase content of milk.

FORSTER, T. L., JENSEN, C., AND PLATH, E. *J. Dairy Sci., 38,* 764-74 (1955).

A photometric method for estg. the lipase content of whole milk is presented which makes use of esters as substrates and in which color is developed with reagent.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Amino acid composition of crystalline α-lactalbumin.

GORDON, W. G., AND ZIEGLER, J. *Arch. Biochem. Biophys., 57,* 80-6 (1955).

The amino acid compn. of α-lactalbumin has been detd. by chromatography on Dowex 50 resin. Outstanding features of its compn. are high content of aspartic acid and tryptophan and low content of arginine, methionine, and proline. The analytical results yield a mol. wt. of 15,500, in good agreement with phys. measurements. The recovery of serine and threonine from α-lactalbumin hydrolyzates remains const. with increasing time of hydrolysis.

The browning reaction in potato chips.

SHALLENBERGER, R. S. *Dissertation Abstr., 15,* 968 (1955).

A scheme for the cumulative development of color in potato chips is presented based on interpretation of results with model systems studies, potato chips, and "reconstructed" synthetic browning systems. It emphasizes the reactivity of the N compds., and also the N-free components to be found in potato tubers required to quantitatively account for the major portion of pigment that may be developed when tubers from a no. of treatments are processed into chips.

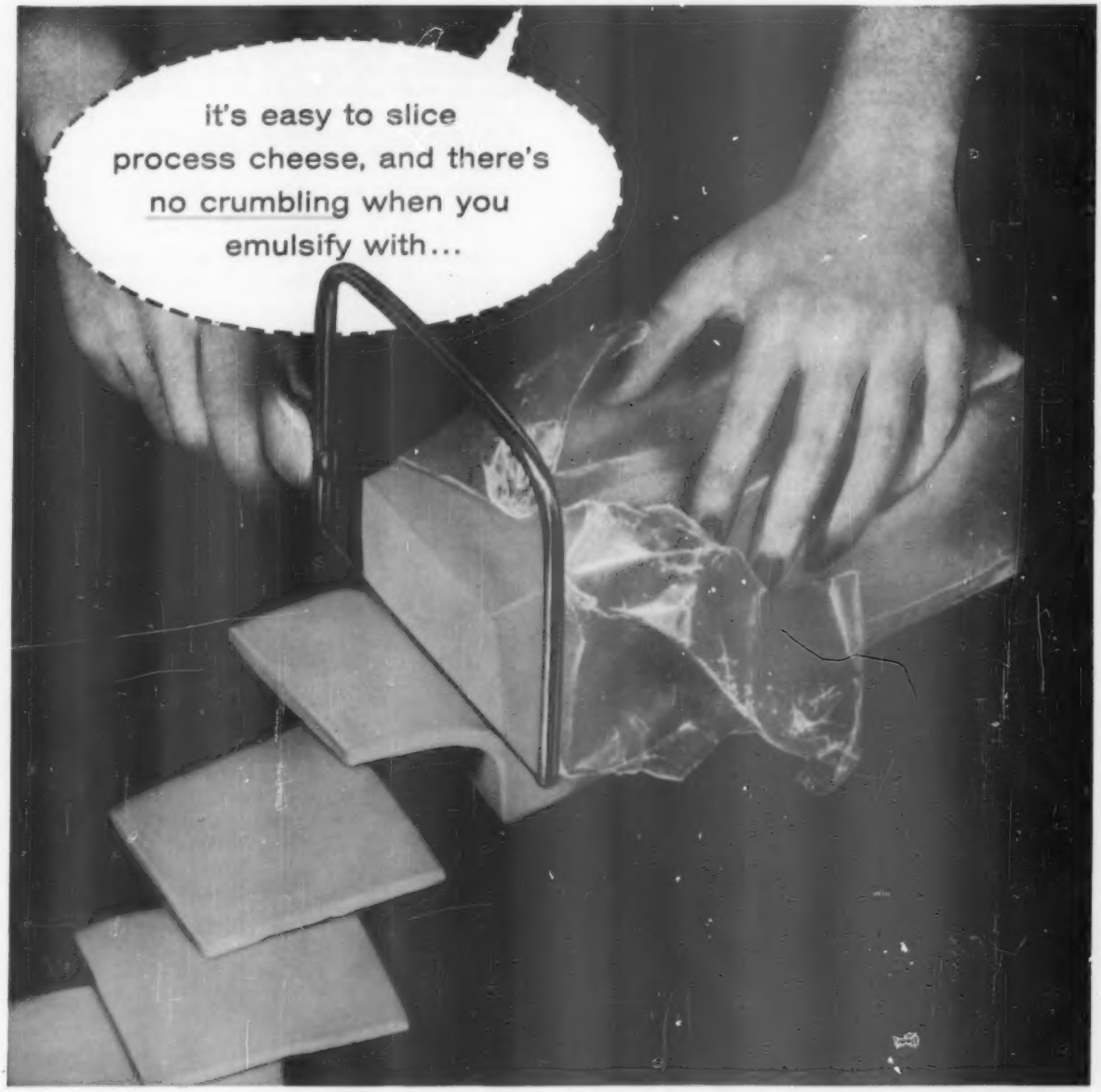
Biological evaluation of proteins.

ALLISON, J. B. *Physiol. Revs., 35,* 664-700 (1955).

The primary function of dietary proteins is to furnish a mixt. of amino acids of the proper pattern for the synthesis of tissue proteins, and all methods for estg. the nutritive value of

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Dr. H. A. Campbell and the General Foods Corporation of White Plains, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

(Continued on page 16)



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SELECTED ABSTRACTS

(Continued from page 14)

a diet evaluate directly or indirectly this function. Such an evaluation involves consideration of the whole process of metabolism as it is revealed in each cell or tissue and in the dynamic state of the body as a whole. A review of methods for the detn. of nutritive value of dietary proteins becomes more meaningful, therefore, if these methods are presented against a background of tissue protein metabolism. 395 references.

Studies on protein denaturation.

WATSON, M. T. *Disseration Abstr., 15,* 511-12 (1955).

Part I is concerned with the increase in the viscosity of solns. of egg albumin and bovine serum albumin resulting from the denaturing action of urea at various values of the pH. Part II describes spectrophotometric studies on Congo red in the presence of native, heat-denatured, and urea-denatured egg albumin and serum albumin.

The selective degradation of wheat gluten.

WISEBLATT, L., WILSON, L., AND MCCONNELL, W. B. *Canad. J. Chem., 33,* 1295-1303 (1955).

A method believed to hydrolyze peptide bonds of proteins selectively at the amino groups of serine was used to obtain polypeptides from wheat gluten.

Hydrolysis of lecithin by plant plastid enzymes.

KATES, M. *Can. J. Biochem. & Physiol., 33,* 575-89 (1955).

Enzymatic liberation of choline from egg lecithin by plastid fractions from sugar beet, spinach, and cabbage leaves and from carrot root was rapid, first order reaction (up to 70% hydrolysis), and was not preceded by a lag phase.

Vitrosin: a member of the collagen class.

GROSS, J., MATOLTSY, A. G., AND COHEN, C. *J. Biophys. Biochem. Cytology, 1,* 215-20 (1955).

Vitrosin, a fibrous protein obtained from the vitreous humor of the eye in the form of an indefinitely long fibril about 100-150A in diameter, has been identified as a member of the collagen class of proteins. It is characterized by the collagen wide-angle x-ray diffraction pattern, and axial periodicity of about 640A detd. by electron microscopy and small-angle x-ray diffraction, an amino acid pattern characteristic of collagen as detd. by paper chromatography, and a hydroxyproline and glycine content also typical of collagen.

Stability of vitamin A in aqueous dispersions and in oils.

PATEL, S. M., KUMTA, U. S., AND RADHAKRISHNA RAO, M. V. *J. Sci. Research (India), 14C,* 17-20 (1955); *Fats, Oils Det., 12,* A:250/142.6 (1955).

There is more destruction of vitamin A in aq. dispersions than in lipid dispersions. Ascorbic acid is a better antioxidant in aq. dispersions. The palmitate is more stable than the vitamin A alc. in oil media; in aq. media the alc. is more stable. There is less stability at pH 3 than at pH 8.

Studies on the heterogeneity of carrageenin.

SMITH, D. B., O'NEILL, A. N., AND PERLIN, A. S. *Can. J. Chem., 33,* 1352-60 (1955).

Studies indicating components of *k* and λ carrageenin are presented.

Concerning the pH optimum of peptic hydrolysis.

CHRISTENSEN, L. K. *Arch. Biochem. Biophys., 57,* 163-73 (1955).

The significance of H^+ concn. to peptic hydrolysis of a no. of proteins has been studied in order to throw light upon certain aspects of the activity vs. pH curves. The more "unfolded" the substrate molecule is, the less does the rate of peptic hydrolysis depend on the H^+ concn. There is a considerable difference between the pH curves for hydrolysis of a native substrate and the corresponding denatured one.

Some biological effects of the flavonoids.

WILLAMAN, J. J. *J. Am. Pharm. Assoc., Sci. Ed., 44,* 404-7 (1955).

There are known at present at least 137 natural flavonoids, occurring in at least 62 families, 153 genera, and 277 species of plants. About 33 different types of physiological and biochem. activities have been reported for one or another of 30 of these flavonoids. This paper summarizes these activities and what is known about the relation of structure to such activities. It is suggested that this is a fruitful field for further research.

MICROBIOLOGY

The chemical reversal of ultraviolet effects on bacteria.

ELLISON, S. A., ERLANGER, B. F., AND ALLEN, P. *J. Bacteriol., 69,* 536-40 (1955).

The lethal and mutagenic effects of u.v. radiation on *Escherichia coli* strain B were reversed by plating the irradiated bacteria in nutrient agar to which Na acetate had been added. Reactivation of irradiated *Corynebacterium bovis* was obtained by the same procedure.

A selenite brilliant green medium for the isolation of Salmonella.

STOKES, J. L., AND OSBORNE, W. W. *Appl. Microbiol., 3,* 217-20 (1955).

A selenite brilliant green enrichment medium for the isolation of *Salmonella* is described. It is more effective in preventing the growth of strains of *Escherichia* and *Proteus* than the commonly used selenite F broth. Although the new medium is highly selective, it supports abundant growth of *Salmonella* from very small inocula.

Bacteriostatic nylon films.

DEFRIES, M. G., AND LEONARD, F. *Appl. Microbiol., 3,* 238-42 (1955).

Hexachlorophene, propyl parasept, and actamer imparted bacteriostatic activity to nylon coatings. These agents also enhanced the stability of nylon solns. All bacteriostatic agents are not effective when dispersed in the plastic matrix. Each specific combination must be tested. Those found to be bacteriostatic may have useful application in surgical dressings for wounds or burns, packaging, or for painting areas which must be kept free of bacterial activity.

Studies on the action of a bacterial α-amylase on amylopectin from waxy maize.

EMERY, D. F. *Dissertation Abstr., 15,* 960-1 (1955).

The ability of the α-amylases to hydrolyze the α-1,4 glucosidic bonds in the vicinity of the α-1,6 branch links of amylopectin has been a subject of considerable controversy. The availability of a purified prepn. of the α-amylase produced by *Bacillus subtilis* afforded an opportunity to study the action of still another α-amylase in this respect. The substrate was waxy maize starch, shown to be essentially free of amylose. The identification of isomaltopentaose as the smallest 1,6 branched oligosaccharide produced by the enzyme indicated that the 1,4 bonds immediately adjacent to a 1,6 bond are rendered stable to α-amylase action. The affinity of the enzyme for a 1,4 bond immediately adjacent to a 1,6 bond appears to be so low that under normal conditions very little, if any, hydrolysis of such bonds is possible.

NUTRITION

Liver necrosis and altered fat composition in vitamin E-deficient swine.

HOVE, E. L., AND SEIBOLD, H. R. *J. Nutrition, 56,* 173-85 (1955).

A fatal liver necrosis developed in growing pigs fed a diet deficient in vitamin E. Six pigs fed this diet from weaning, three died suddenly with massive acute hemorrhagic liver necrosis. Five of the 6 animals in control lots supplemented with α-tocopheryl acetate failed to show appreciable liver damage.

Studies of niacin requirement in man. II. Requirement on wheat and corn diets low in tryptophan.

GOLDSMITH, G. A., ROSENTHAL, H. L., GIBBENS, J., AND UNGLAUB, W. G. *J. Nutition, 56,* 371-86 (1955).

Three subjects were maintained on a "wheat" diet which furnished approx. 5 mg. of niacin and 200 mg. of tryptophan

(Continued on page 18)

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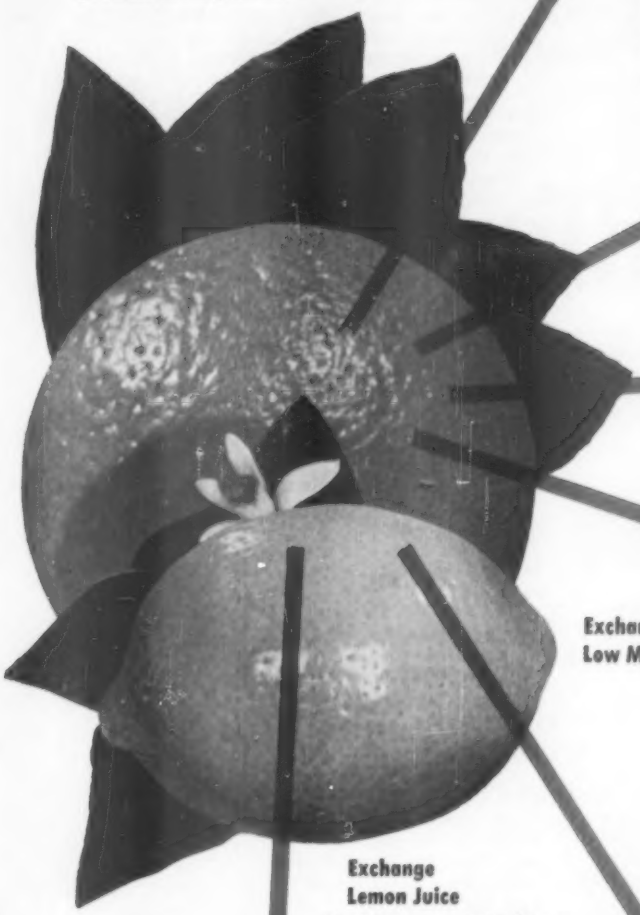

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SELECTED ABSTRACTS

(Continued from page 16)

daily. One subject developed typical niacin deficiency beginning 80 days after the diet was instituted, a second developed amenorrhea, herpes of the lip and slight redness of the tongue papillae, and a third showed lassitude and depression as the only clinical findings. Body niacin stores approach adequacy when the diet supplies 8-10 mg. of niacin.

Diet and enzyme synthesis.

Nutrition Revs., 13, 211-2 (1955).

Data are presented to show some clear cases in which enzymatic adaptation to dietary changes functions to improve digestive efficiency.

PHARMACOLOGY AND TOXICOLOGY

Chronic toxicity of bread additives to rats. II.

GRAHAM, W. D., AND GRICE, H. C. *J. Pharm. and Pharmacol., 7,* 126-34 (1955).

Bread ingredients contg. 50 times the normal concn. of $C10_3$, Pr gallate, and butylated hydroxyanisole, or polyoxyethylene monostearate given as 75% of the diet for 32 weeks, were not harmful to male rats. Na propionate at the same level depressed growth during the first few weeks but did not influence mortality.

The diuretic effect of sorbitol.

LEIMDORFER, A. *Arch. intern. pharmacodynamie, 100,* 161-74 (1954).

A 50% soln. of sorbitol (2.5 ml./kg.) slowly injected intravenously into anesthetized dogs caused marked diuresis. Sorbitol given with the diuretic mercurials doubled the H_2O and tripled the Na and Cl excretion over that after sorbitol alone. With small doses of mercurials, which alone give slight effects, sorbitol causes pronounced diuresis.

FOOD AND FOOD TECHNOLOGY

BAKING AND BAKERY PRODUCTS

Fungal enzymes in bread production.

MACADAMS, L. P. *Food Manufacture, 30,* 274-6 (1955).

Fungal enzymes have been used to correct certain flour defects. The advantages of fungal enzyme tablets (amylase and protease) over malt supplements, when each should be used and when their use is inadvisable, are discussed.

Practices designed to prevent the growth of food poisoning bacteria in meringues.

Bakers Weekly, 167, 38-40+, August, 1955.

1. Employing the hot process under com. conditions and attaining a temp. of 132° F.-134° F., the total bacteria count of whipped meringue was reduced 99.8%. 2. Most cans of frozen egg whites examd. had low initial total bacteria counts. 3. The browning process cannot be relied upon to destroy all *Salmonella,* although significant reduction in nos. may occur. A meringue with 50% dextrose and cream of tartar prevented growth of *Staphylococci* and *Salmonella.* 5. Some growth of *Staphylococci* occurred in a 50% sucrose meringue, but *Salmonella* were suppressed.

Some characteristics of spray-dried wheat gluten.

MCCONNELL, W. B. *Can. J. Technol., 33,* 256-64 (1955).

Spray dried AcOH dispersions of wheat gluten gave a gluten which was found to be an acceptable flour additive for baking. The spray-dried gluten additive gave larger loaf volume than "pure" cake flour or cake flour with a non-spray dried gluten.

COFFEE

Measuring coffee's flavor and aroma.

PUNNETT, P. W. *Tea & Coffee Trade J., 109,* 24+, August, 1955.

This is the first of a series of tech. articles on the coffee industry. The author summarizes basic information on coffee flavor and aroma and criticizes the industry's lag in scientific research to det. effects of roasting and brewing on coffee beans.

U. S. housewives use regular coffee at a rate of 62.7 cups per pound.

Tea & Coffee Trade J., 109, 30, August, 1955.

Results of a survey made for the Pan American Coffee Bureau indicate that the average housewife uses regular coffee at the rate of 62.7 cups/lb. It further showed that she is using soluble coffee at the rate of 14.7 cups/oz.

FATS AND OILS

Essential fatty acids.

THOMASSON, H. J. *Fette u. Seifen, 57,* 390-3 (1955).

Using a new biol. method for the evaluation of essential fatty acids (vitamin F), a great no. of oils and fats as well as fatty acid prepns. was tested. The results of the expts. indicate that the existence of double bonds in the positions 6:7 and 9:10 (counted from the terminal methyl group) is significant for the biol. activity.

Extraction of soybeans theory and mechanism.

OTHMER, D. F., AND AGARWAL, J. C. *Chem. Eng. Progr., 51,* 372-8 (1955).

Article contains data correlating rate of extn. of oil from soy beans by hexane with the thickness of the soy bean flakes, the residual concn. of oil, and time. It is shown that the initial oil concn. in the hexane (up to 20%) does not affect the extn. rate.

FLAVORS AND FLAVORING

Spice flavors in the meat industry.

GUENTHER, E. *Proc. 5th Conf. on Research, Am. Meat Inst., 1953,* 88-96 (1954).

A short general description is given of the principal substances used in the flavoring of meat products, with references to reliable works on official standards and methods of assay. The main types of flavoring material as listed.

FRUIT JUICES

The identification of some volatile constituents of Concord grape juice.

HOLLEY, R. W., STOYLA, B., AND HOLLEY, A. D. *Food Research, 20,* 326-31 (1955).

Ethanol, MeOH, ethyl acetate, methyl acetate, acetone, acetaldehyde, methyl anthranilate and AcOH have been identified as volatile constituents of Concord grape juice. In addn., the presence of at least one unidentified, chloroform-extractable constituent has been established.

The state of combination of the carotenoids of Valencia orange juice.

CURL, A. L., AND BAILEY, G. F. *Food Research, 20,* 371-6 (1955).

The compn. of the 3 major carotenoid fractions sepd. on countercurrent distribution of unsaponified valencia orange juice lipids has been investigated. Two carotenoids not previously found in orange juice or apparently elsewhere in nature were discovered.

FROZEN FOODS

The Protan process for the freezing of fish.

HELGERUD, O. *Kaltetechnik, 6,* 190-3 (1954); *Food Sci. Abstr., 27,* No. 1137 (1955).

Alginates were used experimentally in the block-freezing of herring. The results of a long-term freezing expt. showed that herring frozen by this procedure were of good quality and compared favorably with fresh fish. Attempts are also being made to use alginates in the freezing of soft fruits.

GELATIN AND GUMS

The configuration of gelatin in solution.

GOUINLOCK, E. V. *Dissertation Abstr., 15,* 988-9 (1955).

A discussion of the configuration of gelatin in soln. in terms of chain statistics is presented. It is concluded that gelatin is a

(Continued on page 20)

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SELECTED ABSTRACTS

(Continued from page 18)

highly flexible mol. and comparable in its unperturbed configuration to synthetic linear polymers. On this basis, the gelatin is found to be coiled in soln. to a small fraction of its extended length. A value of 2.1 has been found for the ratio of the chain displacement length in the absence of long-range interactions to the value assuming free rotation about all valence bonds.

Observations on solidification-period of the reversible sol-gel transformation.

KATSURAI, V. T., AND INOUYE, K. *Kolloid-Z., 142,* 162-3 (1955).

Agar-agar, gels and gelatin gels revert to the sol. state when shaken. Upon standing a gel is formed again; but it is formed much faster if the sol. is heated up quickly and then cooled. The term thermopexy (analogous to rheopexy) has been proposed for this behavior.

A preliminary investigation of canna gum.

STRITTMATTER, D. A. *J. Am. Pharm. Assoc., Sci. Ed., 44,* 411-14 (1955).

Canna gum was found to be an efficent, non-toxic, emulsifying agent, and a potential substitute for foreign-produced gums already in use.

LEGISLATION

Cacao products; cheeses and related foods; canned fruit; fruit butters and related products; tomato products.

FOOD AND DRUG ADMINISTRATION. *Federal Register, 20,* 5975 (1955).

Proposal that regulations for cacao products; cheeses; canned fruit; fruit butters; and tomato products be amended by specifying glucose sirup as optional ingredients for each of such foods on the same basis and subject to the same limitations as prescribed for corn sirup.

STARCHES

The partial degradation of starch with mineral acid.

VAN FOSSEN, P. *Dissertation Abstr., 15,* 502-3 (1955).

A study of the types of linkages present in thin-boiling starch and acid modified waxy maize starch by means of acid degradation and by hydrolysis with α- and β-amylose.

TASTE AND TASTE TESTING

A taste panel study of cyclamate-saccharin mixture and of its components.

VINCENT, H. C., LYNCH, M. J., POHLEY, F. M., HELGREN, F. J., AND KIRCHMEYER, F. J. *J. Am. Pharm. Assoc., Sci. Ed., 44,* 442-6 (1955).

Taste panel technics were used to study the relative sweetness and the incidence of off-taste in solns. of cyclamate, of saccharin, and of their 10:1 mixt. This confirms the statement that saccharin sodium is 350 or more times sweeter than sucrose near its sweetness threshold, and that the sweetness factor declines as the concn. increases. This drop was found to be more rapid than previously believed. The Ca salt of saccharin was found to be less sweet than the Na salt.

Influence of monosodium glutamate on taste perception.

PILGRIM, F. J., SCHUTZ, H. G., AND PERYAM, D. R. *Food Research, 20,* 310-14 (1955).

Results of this work do not support the hypothesis that monosodium glutamate acts as a general intensifier of flavor. It probably simply contributes a flavor of its own to a complex food flavor.

ORGANIC CHEMISTRY

The structure of the oligosaccharides produced by the enzymic breakdown of pectic acid. Part II.

JONES, J. K. N., AND REID, W. W. *J. Chem. Soc.,* 1890-1 (1955).

Enzymic hydrolysis of apple pectic acid produced a disaccharide which consisted of 2 D-galactopyruronic acid residues joined by an α-glycosidic linkage (I; R = CO_2H). This diuronide was converted into 4-O-α-D-galactopyranosyl-D-galactopyranose.

The synthesis of DL-threonine.

IZUMI, Y., AND KONISHI, S. *J. Chem. Soc. Japan Pure Chem. Sect., 74,* 957-9 (1953).

Stabilization of autoxidizable materials by means of inclusion.

SCHLENK, H., SAND, D. M., AND TILLOTSON, J. A. *J. Am. Chem. Soc., 77,* 3587-90 (1955).

Adducts of α-dextrin (cyclohexaamylose), β-dextrin (cycloheptaamylose) and deoxycholic acid were prepd., with linoleic acid, linolenic acid, methyl linolenate, cinnamaldehyde and vitamin A palmitate. They were found to be resistant to autoxidation. The principle of inclusion stabilization was established by these examples and by the previous work on fatty acid stabilization by means of urea.

PACKAGING

Insect repellency in multiwalls.

ARNOLD, K. A. *Modern Packaging, 28,* 120-1+, August, 1955.

Bags treated with non-toxic pyrenone in surface coating are found completely resistant to insect penetration. Surface coating was found to be more effective than impregnation bags using the same amts. of pyrenone. Other insecticides are briefly discussed.

PHYSICAL RESEARCH

Critical Reynolds number for flow in tubes and the entropy principle.

MEISSNER, W., AND SCHUBERT, G. U. *Ann. Physik (6), 3,* 163-82 (1948).

The transition from laminar to turbulent flow occurs at the point where the entropy for ideal turbulent flow is greater than that for laminar flow.

MISCELLANEOUS INFORMATION

Changing food patterns of the American people.

BURK, M. C. *Canning Trade, 78,* 10-11+, August 15, 1955.

This review of major types of changes in American food patterns in the past 50 years emphasizes the improvement in quality, decreases in consumption rates of carbohydrates and changes in form due to improvements in food preservation methods.

Portable inexpensive plastic safety hood for bacteriologists.

PHILLIPS, G. B., NOVAK, F. E., AND ALG, R. L. *Appl. Microbiol., 3,* 216-17 (1955).

An inexpensive, collapsible plastic safety hood has been designed and constructed for enclosing certain hazardous operations with infectious microorganisms. It can also be used for operations with certain dangerous or toxic chemicals. Ventilation can be provided to prevent the outward escape of air-borne particles. An air lock is provided for the entrance and exit of materials. The design shown is for use by one technician who works through attached rubber gloves.

PATENTS

Telltale for frozen food packages.

BECKETT, J. S., AND MARENUS, W. J. Assignors to Aseptic Thermo Indicator Co. 2,716,065, August 23, 1955.

A telltale device for a refrigerated package comprising a semi-solid ionic diffusion mass contg. a pH indicator substance and H_2O; and a reservoir having H_2O-dispersed ions available at a surface arranged in communication with the diffusion mass, the dispersed ions being selected as to pH to be effective to change the color of the pH indicator substance upon contact therewith when the ions from the reservoir diffuse by ionic migration into the mass.

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President Clifcorn Announces Committee Appointments

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(Continued on page 24)

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1955	
December 1-3	American Society of Refrigerating Engineers, Traymore Hotel, Atlantic City, New Jersey
1956	
January 12-14	Council of Participating Institutions of Argonne National Laboratory: Conference on the Use of Isotopes in Agriculture, Michigan State University, East Lansing, Michigan
February 6-17	Ice Cream Short Course, North Carolina State College, Raleigh, North Carolina
February 21-24	Dairy Laboratory Short Course, School of Agriculture, North Carolina State College, Raleigh, North Carolina
March 13 and 14	Fourth Annual National Dairy Engineering Conference, Kellogg Center, Michigan State University, East Lansing, Michigan
March 15-16	First International Symposium on Physics in the Food Industry, the Institute of Food Technologists and the Southwest Research Institute, Sponsors, Plaza Hotel, San Antonio, Texas
April 8-13	One hundred and twenty-ninth National Meeting of the American Chemical Society, Dallas, Texas
June 10-14	**Sixteenth Annual Meeting of the Institute of Food Technologists, Hotel Jefferson, St. Louis, Missouri**
June 18-22	International Congress on Food Distribution, Rome, Italy

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(Continued form page 22)

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J. R. Vickery, Jr.

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F. L. Gunderson

Liaison Representative to the Food Protection Committee—National Research Council

L. E. Clifcorn

Books

Handbook of Food and Agriculture. Edited by Fred C. Blanck, with 29 contributors. The Reinhold Publishing Corporation, New York, N. Y., 1039 pages.

In the preface to the *Handbook of Food and Agriculture* Dr. Blanck, the editor, points out that food and agriculture together make up the largest American industry. People need to be reminded that it is also our most vital industry. In recent years advances in research in both fields have been tremendous, outstripping in many areas the comprehension of the nonspecialist. These advances have resulted in improved production and processing equipment, new crop varieties, improved breeds of animals, improvements in storage and handling, better utilization of crops, better methods of manufacture and distribution, a greater volume of production, and better nutritional value from our foods. The editor candidly admits that it has been impossible to cover all phases of the two great fields and, because of this, potential chapters concerned with agricultural engineering, genetics, plant pathology, animal breeding and climatology have been left out. Other important fields such as horticulture and animal husbandry have also been omitted. If it were not for the dire need for a handbook that will encompass and integrate food and agriculture research, these omissions could go unnoted.

Scope. The book contains 1039 pages divided into 26 chapters and an appendix. The scope of the book is already tremendous. As was probably planned, originally, it would have covered the complete field of agriculture, the transportation of agriculture products, food processing, and all phases of the food laws pertinent to the interests of food processors and purveyors. Most certainly this is a meritorious, most ambitious undertaking. Indeed it is a worthy one, and it is only unfortunate that the work could not have been extended into two volumes so that all phases of this vast and impressive field could have been covered adequately. Today, more than ever before, food production and food manufacture are crucial factors in the continued progress of civilization. Not only food technologists but also economists, sociologists, and statesmen need to have a source that outlines the intricate techniques required to produce food crops, prepare them for consumption, and distribute them to massive populations.

Analysis of content. The first four chapters of the *Handbook* are concerned with soils, the next two with insecticides, fungicides, herbicides, and growth regulants. Three chapters may be classified as biochemical; three are concerned with spoilage and deterioration; six with commodities. Others consider storage, food engineering, packaging, quality control, waste, chemicals in foods, and the Food, Drug, and Cosmetic Act. One hundred and eleven pages are devoted to an appendix which contains a great deal of useful information.

Most of the chapters are valuable from the standpoint of orientation in a particular area; a few, however, are rather superficial. But something good can be said about most of the chapters as well as about the appendix. No doubt readers will differ in their selection of "best chapters." Those relating to insecticides, oxidative rancidity and antioxidants, storage of agricultural raw products, food preservation, cereals and cereal products, dairy products, the chemistry of plants, food quality and quality control, disposal of food plant wastes, and chemicals in foods were of greatest interest to the reviewer.

Minor details. Although the chapters just listed were read with enthusiasm, certain minor points bothered the reviewer. In the chapter concerned with insecticides the great importance of the effect of agricultural chemicals on taste and acceptance of the processed product was ignored. Overlooking this important point in the past has caused serious losses in certain areas of the food industry. The chapter on plants would have been more useful if the source of tabular material had been indicated under each table. The reader might then, if he cared to do so, be enabled to seek out the original information. It is also unfortunate that some consideration was not given to distillery waste in the chapter concerned with the disposal of food plant waste.

Format. The makeup of the book is good; the printing and format make it easy to read; the index is adequate and useful. As pointed out by the editor, however, no effort was made to obtain chapters uniform in style and organization from the various contributors. This is very apparent and somewhat bothersome when one goes through the book.

The audience. This Handbook of Food and Agriculture will be useful to anyone desiring an orientation into one or more fields of the broad area covered by the book. It should be of particular interest to those who maintain an interest in the rapidly occurring advances in their own and related fields but have neither the desire nor the time to dig through volumes of literature to learn about them. It also should prove useful to students seeking information for term papers, seminars, or a quick insight into particular fields. As mentioned, it will have collateral usefulness for economists, sociologists, statesmen and others.

Notes for future use. In conclusion, the publisher and editors need hardly be told that the road to perfection in such a bold and worthy enterprise is successive revisions and perhaps expansion into two or more volumes. It may be hoped that the understandable re-

(Continued on page 26)

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BOOKS

(Continued from page 24)

luctance expressed in the preface for the inclusion of chapters such as one dealing with horticulture, an indispensable key to understanding certain food manufacturing problems, may be overcome. We need those chapters. Another gap might be filled by including in the appendix methods and nomenclature used in agricultural studies. The list, beginning on page 966, relating to research groups dealing with foods should be expanded. These suggestions for use in future revisions are not offered negatively. They are offered in the hope that this commendable pioneer effort will develop into a classic, a permanent source of reference commensurate with the stature of "food and agriculture." In the meantime it is a pleasure to acknowledge the great accomplishment of the editor, Dr. Fred C. Blanck, and his contributors in blazing the trail through an immense forest of literature.

EMIL MRAK
Davis, California

FOOD SERVICE IN INSTITUTIONS (Third Edition). Bessie Brooks West and Levelle Wood. John Wiley and Sons, Inc., New York, N. Y. 682 pages.

"Food Service in Institutions" gathers together a vast amount of information important to anyone engaged in large scale feeding operations. The three sections, entitled "Quantity Food Production," "The Organization and Administration of Food Services" and "Food Service Planning; Selection of Furnishings and Equipment for Institutional Kitchens and Dining Rooms" in a large measure cover the field of feeding, from food chemistry and composition to labor management and kitchen construction.

Whereas the earlier editions of the book fulfilled an urgent requirement for a general survey of the feeding field, similar to the way Prescott and Proctor's "Food Technology" covered the food field, in its third edition, "Food Service in Institutions" seems to have gone beyond the student's indoctrination or integration course and has become a casebook for the feeding specialist. While in the Preface the authors explain that the reader should possess a basic knowledge of food and nutrition in order to properly use their book, they then proceed to give a considerable amount of food chemistry and nutrition through which the book user must wade to reach the kernel of each chapter.

While still in a criticizing mind, it is important to indicate that some material dates back to or beyond the first edition of the book such as: "Dry Ice" seems to be the sole method used in transporting meats and other frozen foods, "pan frying" is continually mentioned while "grilling" and French frying are little noted and deep fat frying only appears under Fats and Oils. Little mention is made of chemical and mechanical meat tenderizers, mechanical vegetable cutters, infra-red cookery, and precooked frozen foods. On the other hand, pictures of the latest steam cooker and deep fat fryer are included and a number of references published in 1954 are quoted.

The book has many outstanding features of which the chapter on "Development of Food Services in Institutions" is not the least. There is just enough "History" in this chapter to lead one to look forward to the day when an enterprising individual will write a popular history book on "Foods, Fads, and Feeding."

The authors are to be commended on the way they have emphasized the problems and presented the presently available solutions in small and large feeding operations. One is impressed by the multiplicity of considerations that beset a feeding specialist and the wide-open field that is open to the food technologist, industrial engineer, and equipment engineer to bring about improvements and reduce problem areas.

If *you* have problems in food procurement, food preparation, cost control, personnel management, sanitation or feeding equipment, "Food Service in Institutions" will give you a good start in their solution.

ARTHUR C. AVERY
Bayonne, New Jersey

RUTIN AND RELATED FLAVONOIDS — CHEMISTRY, PHARMACOLOGY—CLINICAL APPLICATIONS. John Q. Griffith, M.D., Charles F. Krewson, Ph.D., and Joseph Naghski, Ph.D. Mack Publishing Co., Easton, Penna., 275 pages.

The flavonoid compounds have been investigated actively for a number of years from various points of view by geneticists, physiologists, chemists and biochemists. Astringency of foods of plant origin, color stability, and appearance and color acceptability of certain food products is known to be related to their flavonoid content. The therapeutic activity of several flavonoids, both as pure chemical compounds and in crude preparation, although it was discovered certainly in 1931, and probably observed even earlier, first received general recognition with the announcement by Szent-Györgyi and his collaborators in 1936 that two crude flavone preparations from lemon peel, "citrin," hesperidin and its dimethyl derivative, also exerted a sparing action on ascorbic acid. They found that guinea pigs on a scorbutogenic diet did not develop scurvy when these flavonoids were added to their diet. Although he referred to the biologically active principle as "vitamin P," this term is now in disrepute and the more valid term "bio-flavonoid" is applied to the several chemically defined flavonoids possessing the desired physiological activity. Of these rutin, a flavonol glycoside which can be prepared in a highly purified state, has been more widely investigated and used. Rutin was isolated from tobacco by Dr. James F. Couch and his collaborators at the Eastern Utilization Research Branch, Agricultural Research Service, U.S.D.A., in 1941 and subsequently (1946) the Tartary strain of buckwheat. The latter so far is the best domestic source of rutin, since it contains 3 to 6% rutin on a dry weight basis. At the suggestion of Dr. Couch an extensive clinical evaluation of rutin as a therapeutic agent for capillary fault was undertaken in 1942 and continued since his death in 1951. The extensive clinical research carried out on rutin by Griffith and his collaborators which led to its use by physicians since 1946, is critically evaluated in this book and useful and interesting data on the chemistry and production of rutin is presented.

(Continued on page 28)

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BOOKS

(Continued from page 26)

The recent investigations indicating that quercetin, the aglycone of rutin, is even more effective in correcting capillary fault also is presented in some detail. The occurrence, isolation and chemical and physical properties of rutin, including analytical procedures, are discussed in detail. The pharmacology of rutin and related flavonoids of similar chemical, pharmacological and physiological property is clearly and fairly extensively discussed. Most of the book, however, is devoted to capillary fault both from the general physiological and clinical aspects. The general physiology of vascular fault, capillary permeability, capillary fragility, effect of rutin therapy on capillary fault, mortality, retinal hemorrhage and in other vascular abnormalities is discussed in some detail. The interesting effect of rutin therapy in preventing loss of tissue in experimental frostbite in rabbit's feet and the critical evaluation of flavonoid therapy in radiation injury will be most useful to investigators interested in preventing damage to living cells by physical agents. Although the mechanism of action of rutin and related flavonoids as therapeutic agents and their role in animal physiology is as yet not fully understood, the objective of the authors, a definitive evaluation of the use of rutin and other flavonoids in human medicine, has been comprehensively and objectively accomplished. The bibliography of over 800 references cited in the text, while not complete, will be most useful to the serious reader. The style of presentation, and the printing and binding are excellent. This monograph is highly recommended.

The continued and sustained interest in the chemistry and physiology of bioflavonoids is well exemplified in the conference on bioflavonoids and the capillary held by the Section of Biology of the New York Academy of Sciences on February 11, 1955. The series of papers presented then have been published in the Annals of the New York Acadamy of Sciences vol. 61, art. 3, pp. 637-736, July 8, 1955. This article consists of seven papers comprising the laboratory studies and six on clinical studies. It is indeed fitting that Dr. Albert Szent-Györgyi should have co-chaired the conference and delivered the concluding paper on "perspectives for the bioflavonoids" in which he postulated that "The reactions of flavones with metals hold the key to the understanding of their biological function, while the flavonoid metal complexes may hold the key to a better understanding of the working of the machinery of life."

M. A. Joslyn
Berkeley, California

Principles of Emulsion Technology. Paul Becker, Reinhold Publishing Corp., New York, 1955 (A Reinhold Pilot Book No. 5), 149 pages.

This rather short dissertation brings together the physico-chemical principles governing emulsion technology. These principles can be found in any book on colloidal chemistry, but the author has combined these principles with a presentation of general industrial examples of emulsion technology, including brief descriptions of emulsification equipment, testing emulsion properties, emulsion formulation, and finally a mention is made of problems of demulsification, and the techniques of overcoming them.

The first two chapters deal strictly with the principles of colloidal chemistry which are operative in the field of emulsions. A very brief description of dispersions and emulsions is presented, followed by a more detailed discussion of surface activity. The next two chapters are devoted to the theory of emulsions and the chemistry of emulsifying agents. Included in this section are discussions of the potential energy of emulsions, of the different types of emulsions, and interfacial adsorption and emulsion stability as well as a description of the agents that are used for stabilizing emulsions and the manner in which they produce stability. Special mention is made of the type of agents that serve the most useful industrial purposes.

In the chapter on emulsion formulation, the author gives information on the choice of emulsifying agents, the methods of emulsification, and the emulsions used in various industries; e.g., cosmetic, food, paint, etc.

This book does not present any particularly new information in the field of emulsion technology, but does bring the principles together in a short, well presented, easily read book.

Robert B. Koch
Broadview, Illinois

Analysis of Insecticides and Acaricides. Francis A. Gunther and Roger C. Blinn, Interscience Publishers, Inc. New York, XI + 696 pages.

This is the sixth of a series of monographs on analytical chemistry and its application, edited by Beverly L. Clarke and I. M. Kolthoff. It is a most timely and welcome treatise on sampling, isolation and determination of insecticides and acaricides. The widespread use of synthetic organic chemicals for the practical control of insects (hexapods or six-legged arthropods) and arachnids (eight-legged arthropods, spiders and mites), since 1940, has emphasized several problems previously not significant in the fields of practical insect control. On the one hand the more efficient control of plant pests by the use of these insecticides has resulted in marked increases in yield and in economic production of agricultural crops with little or no insect damage. On the other hand the possible presence in foods of amounts of persisting insecticides, particularly the penetrating or systemic insecticides, which may accumulate and be involved in chronic toxicity, has been of particular concern to Federal and State agencies charged with the responsibility for safeguarding public health and to food technologists. The presence of organic insecticides in foods in detectable concentration and the appreciable deleterious effect of some of them upon flavor and acceptability of processed foods has focussed the attention of food technologists upon the dangers involved in their use. The food processor, on the one hand, is restricted in the processing and marketing of foods, particularly of plant origin, containing evidence of insect infestation (insects, insect fragments, insect excreta) and on the other hand he is restricted in the marketing of processed foods which, though free of insects or insect damage, contain detectable concentrations of insecticide

(Continued on page 36 following technical papers)

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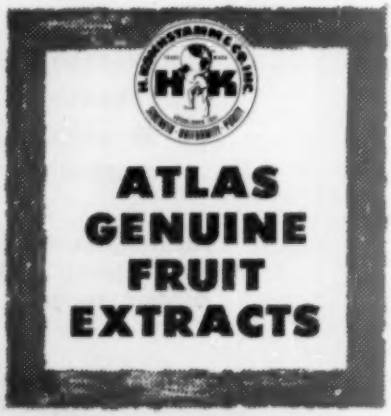

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A Continuous Process for Smoked Meat. I. Development of a Process[a]

J. W. HANLEY, H. NED DRAUDT AND M. C. BROCKMANN
Research Laboratories, Kingan Inc., Indianapolis, Indiana

(Manuscript received June 21, 1955)

In recognition of the time and handling costs for the processing of smoked meats in a conventional smokehouse, the basis for a commercially feasible continuous process was sought. Attention was directed toward electrostatic smoke deposition and infrared heating. Laboratory equipment for electrostatic smoking of bacon was developed. Under conditions established as optimum, normal smoke character is imparted in approximately 3 minutes. By use of rod type infrared heating equipment, bacon is given adequate heat treatment within approximately 25 minutes. By combining electrostatic smoke deposition with infrared heating, bacon is prepared in 30 minutes which has flavor, odor, color, color stability and resistance to microbial and oxidative deterioration equal to that obtained by conventional smokehouse procedure. The processes developed for electrostatic smoke deposition and infrared heating are readily adaptable to a continuous process.

In the meat packing industry, a smokehouse serves three basic functions, smoking, heating, and drying. These functions are reflected in distinctive and desirable characteristics of smoked meats, as described by Jensen *(4)*. To give a clearer perspective on these characteristics, it is advantageous to distinguish between the effects contributed by the smoke itself and the effects induced by the physical environment of the smokehouse.

Among the effects identified with the smoke the most significant from the commercial standpoint, is flavor. This distinctive flavor together with a smoked appearance of the surface are established as essential characteristics of smoked meats. Chemical components of wood smoke are known to impart preservative action both antibacterial, as recently confirmed by Gibbons, Rose and Hopkins *(3)*, and antioxidative, as indicated by Lea *(5)*. The modern meat packer, however, places little reliance on these effects.

The heating and drying functions of a smokehouse are responsible for a number of chemical and physical changes in the processed meat. Most products processed in a smokehouse are heated to a temperature sufficient to cause protein denaturation, inactivation of enzymes and destruction of a high percentage of the microorganisms that naturally occur on meat. In the presence of nitrite, elevated temperature hastens the development of the pink color that is characteristic of cured meat and a temperature sufficiently high to effect protein denaturation tends to stabilize this color. Heating in combination with low humidity and forced air circulation causes a considerable amount of water to be evaporated during processing. The wide acceptance of injection techniques for introducing aqueous curing solutions into meat has necessarily increased the amount of evaporation that must take place during the smokehouse processing. Further effects attributed to heating and drying are responsible for changes in moisture content, texture, and tenderness of smoked products.

Modern smokehouses, as described by the American Meat Institute *(1)*, provide for precise control of temperature, humidity, air circulation, and smoke density. For processing relatively large meat masses, such as hams and bacon bellies, conventional smokehouses require only small expenditures for heat and electrical power. Cost analysis for such smokehouses, however, reveals a substantial expenditure for labor, much of which is utilized for loading and unloading the smokehouse. Moreover, the expenditure for a smokehouse itself, including the cost of installation, represents a relatively large investment to any packer in need of additional smokehouse capacity. To some extent, the present rotary smokehouse may provide a reduced labor cost, but this type of smokehouse requires a greatly increased investment in both equipment and installation.

From the standpoint of a meat packer confronted with the problem of expanding his production capacity for smoked meats, the preceding analysis suggests a need for developing a process which would produce products equivalent to those now prepared in a conventional smokehouse but at a reduced labor cost and/or with a lower expenditure for equipment and installation. The fact that many industries have succeeded in effecting a substantial reduction in labor cost by converting to continuous processes, focused attention to the desirability of developing a truly continuous process to replace the conventional method of smoking meat products. The experimental observations reported here are directed toward providing a basis for a continuous system for duplicating certain products currently prepared in conventional smokehouses.

EXPERIMENTAL PROCEDURE

In order to simplify laboratory experimentation, all observations were performed on bacon bellies weighing less than 20 pounds which had been injected with curing solution and otherwise treated in accordance with recognized commercial practice. Bacon was selected as the experimental material because of its more or less regular geometry and because it represents a major product in the smoked meats class. In conventional smokehouse operation, bacon is often processed in a smokehouse for 12 hours or more during which time it attains an internal temperature of 120-125° F.; during this time the smokehouse is filled with smoke for 6-8 hours. Such processing schedules preclude the development of a feasible continuous process based on the existing principles of heating and smoking.

Smoking. A survey of the literature combined with exploratory laboratory experimentation indicated that there were only two feasible methods for reducing smoking time to a level consistent with a continuous process. These were the electrostatic deposition of smoke on the belly and the smoking of the sliced product. The second approach was abandoned because sliced bacon is virtually unmanageable and cannot be reassembled into

[a] Presented before the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 13, 1955.

an attractive package; nevertheless, a satisfactory level of smoke flavor can be attained after a few minutes exposure to a high smoke concentration. In preliminary experiments with electrostatic deposition, smoke was passed through a zone containing wires and plates carrying a high electrical potential and then directed toward a suspended belly maintained at ground potential. The voltage on the ionizing plates and wires was obtained by the use of an X-ray rectifier and transformer. Results, as evidenced by the development of smoke flavor and external appearance, were sufficiently encouraging to warrant a systematic study of the factors influencing the electrostatic deposition of smoke.

An experimental system, illustrated in Figure 1, was established in a small experimental smokehouse. Smoke from a

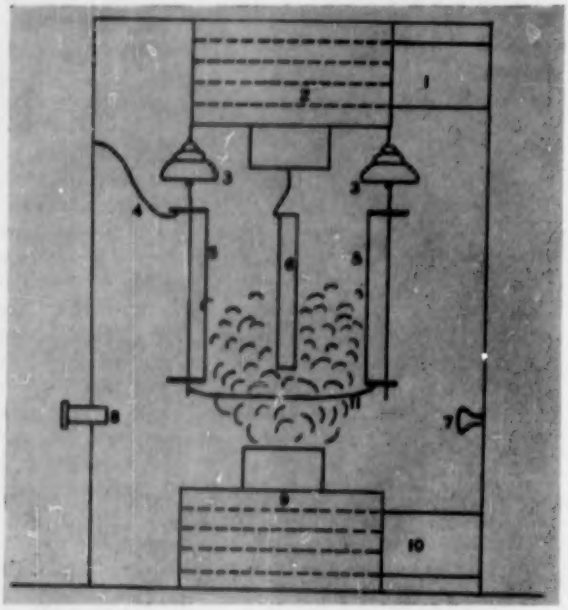

Figure 1. Cross section of experimental electrostatic unit.

1. Smoke exhaust duct.
2. Smoke collector.
3. Insulators.
4. High Voltage lead-in cable.
5. Ionizer assemblies.
6. Sample.
7. Light source.
8. Light meter.
9. Smoke discharge chamber.
10. Smoke inlet duct.
11. High voltage connecting cable.

generator was introduced through a perforated plate situated about one foot above the floor. The smoke moved upward past the plate and wire ionizers which were suspended from insulators. Provision was made for imposing a range of known electrical potential on the ionizing equipment. The bacon belly, maintained at ground potential, was suspended between the ionizers and directly below the smoke exhaust duct. For the purpose of evaluating relative smoke density, holes were cut in opposite walls of the smokehouse above the level of the smoke inlet plate but below the lower portion of the ionizers. A focused beam of light was introduced through one hole and the amount of light passing through the smoke was determined by means of a photographic light meter mounted at the hole on the opposite wall.

The primary objective of this phase of the experimental program was the identification of conditions favorable to the development of smoke flavor in minimum time. Smoke deposition was measured in terms of the relative amount of phenolic materials deposited. In all experiments directed toward establishing conditions for maximum smoke deposition, a wooden board—12 inches long, 9 inches wide, and 2 inches thick—was substituted for a bacon belly. To each side of the board was affixed a sheet of 8½ x 11 inch copy paper representing a total exposed surface of 187 square inches. Prior to each run, both the board and the sheets of paper were thoroughly impregnated with a NaCl solution to simulate the electrical conductivity characteristics of a cured belly. Immediately following each run, the two sheets of paper were removed from the board and assayed for the amount of phenolic materials present. This procedure not only eliminated the consumption of many hundreds of pounds of bacon bellies but also simplified and improved the accuracy of the analytical procedure for determining phenolic materials. The relative amount of phenolic materials deposited on the papers was evaluated by a modification of a procedure described by Emmerie and Engel *(2)*. The two sheets of paper containing deposited smoke constituents were placed in a Waring blender and extracted with 100 ml. of 95% ethyl alcohol for 3 minutes. The extract was filtered and 5 ml. of filtrate was diluted with an equal volume of 95% alcohol. One ml. of the diluted filtrate was transferred to a 100 ml. volumetric flask to which was added 2 ml. of dipyridyl reagent (1 g. alpha-alpha' dipyridyl dissolved in a solution containing 250 ml. of 99.5% acetic acid and 250 ml. of 95% ethyl alcohol) and 2 ml. of ferric chloride reagent (0.832 g. $FeCl_3 \cdot 6H_2O$ dissolved in 250 ml. of 99.5% acetic acid and 250 ml. 95% ethyl alcohol). After allowing 30 minutes for color development, the content of the flask was diluted to 100 ml. with 95% ethyl alcohol. The resulting solution was evaluated for optical density at 510 mμ with a Beckman DU spectrophotometer. In certain cases, the final dilution was modified to permit all samples of an experimental series to be evaluated at a single dilution and still fall within the operating range of the spectrophotometer.

A blank, consisting of ethyl alcohol and reagents, was carried with each series of evaluations. Relative values for the amounts of phenolic materials deposited are reported in terms of the optical density of the solution read on the spectrophotometer after correction for the reagent blank.

Various designs of plate and wire ionizers were examined. Wires were found to be far more effective than plates for ionization of smoke but plates favored channeling the smoke through the system. In addition repulsion of charged smoke particles by the plates aided in directing smoke toward the product. The ionizers as illustrated in Figure 2 when arranged

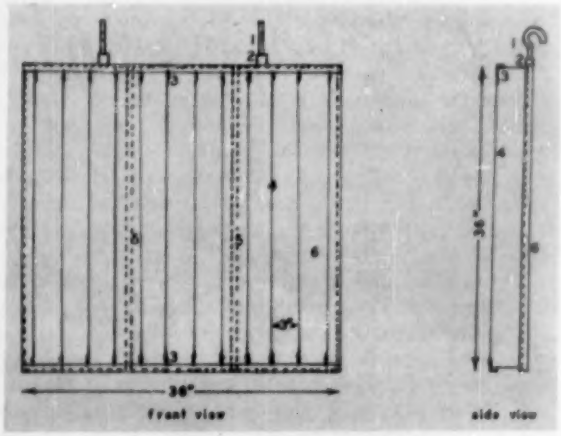

Figure 2. Ionizer assembly.

1. Ionizer hanger.
2. Hanger holder.
3. Tension springs.
4. Ionizing wire.
5. Back brace.
6. Ionizer plate.

in pairs on opposite sides of the broad surfaces of the sample to be smoked, were found to be highly satisfactory, as evaluated by amount of phenolic materials deposited. In addition, this configuration was well suited for integration into a continuous conveyor system.

The preceding observations on ionizer design were performed under conditions in which the distance between the plane of the ionizer wires and the ionizer plate was arbitrarily fixed. Varying this distance was found to have a marked effect on the amount of smoke deposition as illustrated in Figure 3.

In similar manner, other series of experiments were performed to establish the relationship between smoke deposition

and the following: distance between ionizers and sample surface, the voltage on ionizers, smoke velocity, smoke density, and time. Results are shown in Figures 4-8 respectively. In these experiments, unless specifically indicated, the following conditions obtained: (a) distance between ionizer wires their respective plates = 3 inches, (b) distance between ionizer wire and surface of sample = 4 inches, (c) ionizer potential = 40,000 volts, (d) smoking time = 3 minutes, (e) smoke velocity = 80 feet per minute and (f) smoke density = 3.2 light meter units. Although smoke density was maintained constant for an experimental series, considerable day to day variation was encountered.

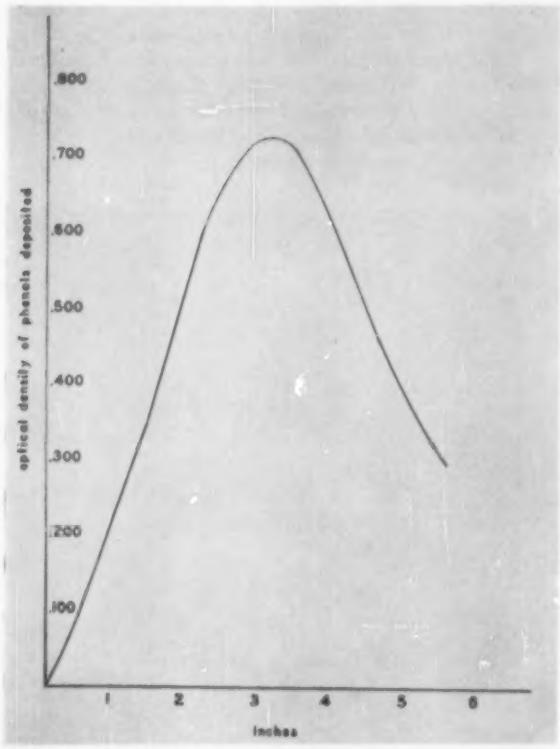

Figure 3. Effect of plate to wire distance upon smoke deposition.

Replacement of the 0.008 in. copper wire in the ionizers with tungsten wire of the same diameter had no detectable effect on the amount of phenolic mtaerials deposited. However, because of its greater tensile strength tungsten wire is preferred for a commercial unit. Likewise, reversing the polarity on the ionizers while maintaining the sample to be smoked at ground potential had no significant effect. Deposition of phenolic materials was evaluated at humidities of 45 and 80%; the difference in smoke was not significant.

In order to evaluate the amount of electricity used by the ionizing system, a milliammeter was connected to the power source. With a potential of 40,000 volts on the ionizers an initial current of 30-35 milliamperes, which eventually stabilized at 28-30 milliamperes, was observed.

Bellies smoked for 3 minutes under optimum conditions as indicated by the preceding experiments developed normal smoked characteristics as evaluated by odor and appearance and by flavor after frying. However, unless subjected to a short heat treatment after smoking, the smoke on the surface of the belly tends to smear or rub off.

Heating and drying. Although heating markedly accelerates the development of the characteristic red color of bacon, the primary reason for heating is to stabilize this color. In addition, heating reduces the bacterial population of bacon and thereby minimizes the tendency toward microbial deterioration. As noted previously, heating also tends to fix the smoke color so that it does not smear. For bellies which have been injected with curing solution, a drying process, which takes place concurrently with heating, is necessary to eliminate excessive wetness and to meet the government requirement that injected bellies be restored to original weight.

Experiments were performed in a conventional type smokehouse in order to ascertain the extent to which processing time could be reduced. This involved a study of the effect of higher temperature, higher humidities and higher air velocities on the heating rate of 8-10 lb. bellies. As illustrated in curves a and b of Figure 9, wet bulb temperature has a marked effect on the rate of heating especially during the period before the belly attains an internal temperature of 100-110° F. Under conventional smokehouse conditions it is difficult to achieve a temperature above 200° F. with a wet bulb reading of 155° F. without resorting to steam cooking. High wet bulb temperatures, however, do not favor drying, and transfer of cold bellies into a high temperature-high humidity environment often results in condensation of water on the surface of the bellies. Although it is possible that convection heating could be made the basis of a continuous process for heating the lightest weight classes of commercial bellies, experimental data cast serious doubt on the feasibility of this type of heating for the continuous processing of even medium weight bellies.

Consideration was given to diathermal heating as described by Pircon *(6)*. Though theoretically attractive, equipment costs for a commercial installation together with an unattractive power cost, discourage consideration at this time. Somewhat more attractive is the possibility of resistance heating. Cursory laboratory experiments showed that while a 30° F. temperature rise could be attained in 12 minutes using this method of heating there was evidence of overcooking in areas of high salt concentration. Furthermore, this type of heating did not produce enough evaporation of moisture to bring the product back to its initial weight. For these reasons, this method of heating was not investigated further.

Although considerable application for infrared heating in the food industry is foreseen by Shuman and Stanley *(7)*, current applications are confined primarily to surface films and relatively thin objects. In order to determine the applicability of radiant

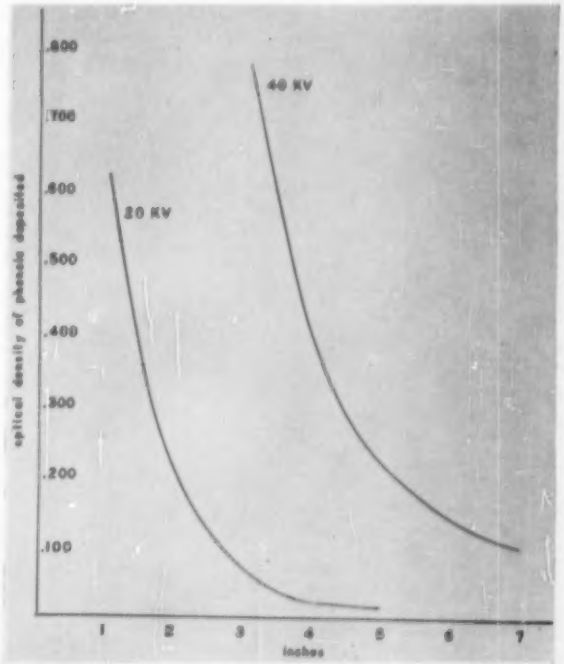

Figure 4. Effect of distance between ionizers and product upon smoke deposition.

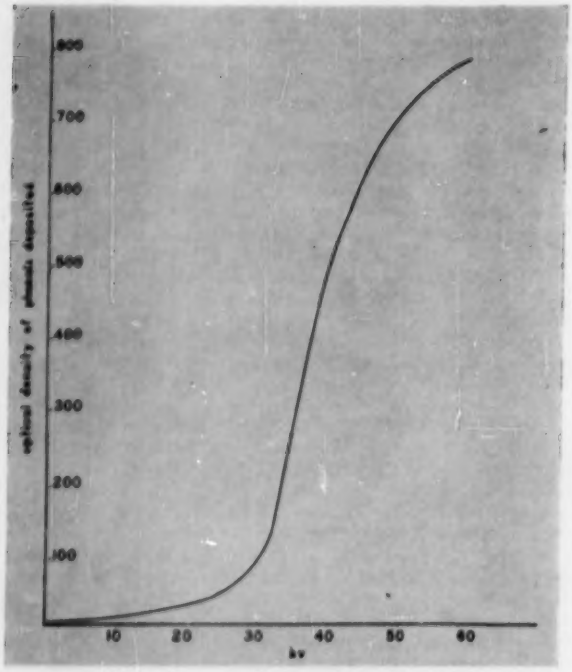

Figure 5. Effect of voltage upon smoke deposition.

heating, an infrared heating oven was made from 8 Chromalox rod type heaters (Edwin L. Weigand Company), each rod 38 inches long with a 5-inch wide reflector. Duplicate sets of 4 rods were mounted vertically at 7-inch centers on metal frames. Frames were oriented to give 2 parallel opposed banks of infrared units. Bellies were suspended midway between the units. Typical results for heating and drying 8-10 lb. bellies are presented in Figure 10. Experimental results indicate that infrared heating can bring the internal temperature in the thickest portion of an 8-10 lb. belly to 120° F. within 22 minutes. Concurrently the belly loses approximately ¼ of the weight necessary to restore it to its initial (pre-injected) weight. These results point to the feasibility of employing infrared to heat and dry bellies on a continuous basis.

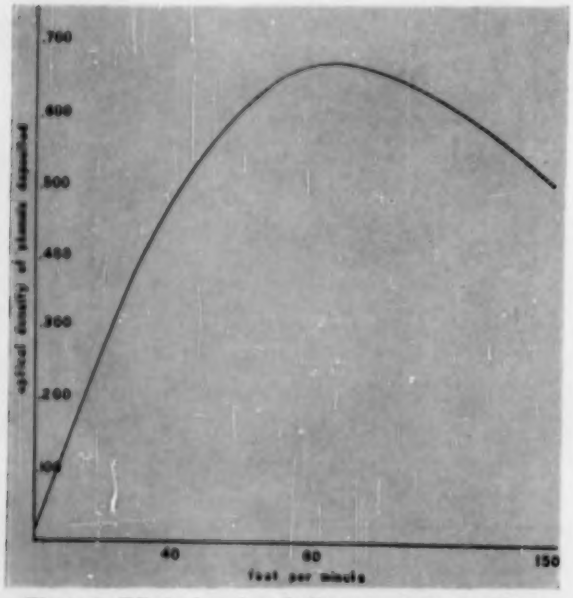

Figure 6. Effect of smoke velocity upon smoke deposition.

PROCESS EVALUATION

In the preceding sections, work on electrostatic smoking and on infrared heating and drying has been advanced sufficiently to permit the application of these processes to the production of bacon. The quality of the bacon so produced is of primary consideration. Without delving into the finer ramifications of quality, the main requirements are acceptable flavor, normal internal color, satisfactory slicing characteristics, and normal stability under the ordinay conditions encounteed in mechandising. Since all of these aspects of quality are relative, premium bacon as prepared by the conventional process was used as a reference standard. At the start of the evaluation program, cured bellies were smoked in the laboratory electrostatic unit and then transferred to the infrared oven for heating and drying. Bacon prepared in this manner frequently lacked smoke flavor when fried, notwithstanding the fact that smoke deposition, as evaluated by the surface appearance of the belly, was excessive. This situation was corrected by heating the bellies to an internal temperature of 125° F. or more prior to smoking and subsequently subjecting them to a brief additional heating period after smoking. This procedure intensified smoke flavor. Many observers indicated a slight taste difference between the experimental and commercial products; however, no significant trend was expressed as to which was preferred.

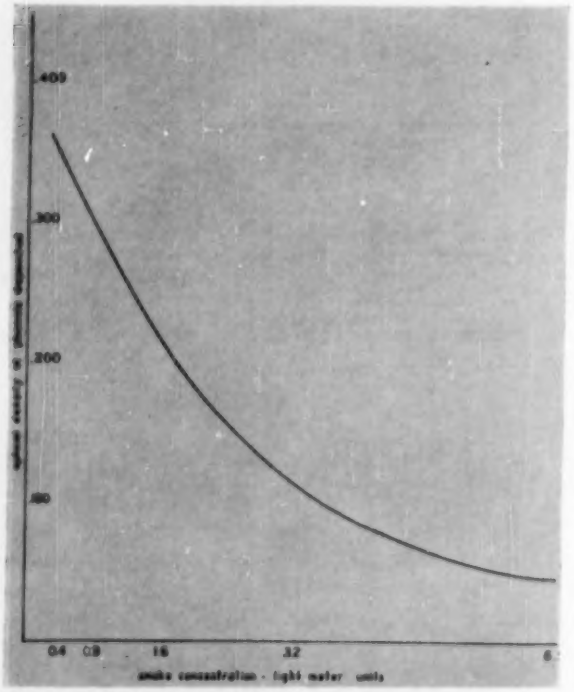

Figure 7. Effect of smoke concentration upon smoke deposition.

It is possible with electrostatic smoking to produce slab bacon with surface color ranging from virtually un-

smoked to a varnished mahogany. Bacon processed electrostatically to a smoke flavor level equal to regular production bacon had only a slightly darker external color; after frying, the bacon usually had a thin dark ring at its periphery.

In order to obtain an objective appraisal of the color of freshly sliced product, as well as the same product after exposure to display conditions, color measurements were made on comparable areas of lean tissue using the reflectance attachment for a Beckman DU spectrophotometer. Representative curves are shown in Figure 11 for both regular production bacon and the laboratory product prepared by electrostatic smoking and infrared heating These curves support subjective observations that at the time of slicing electrostatic

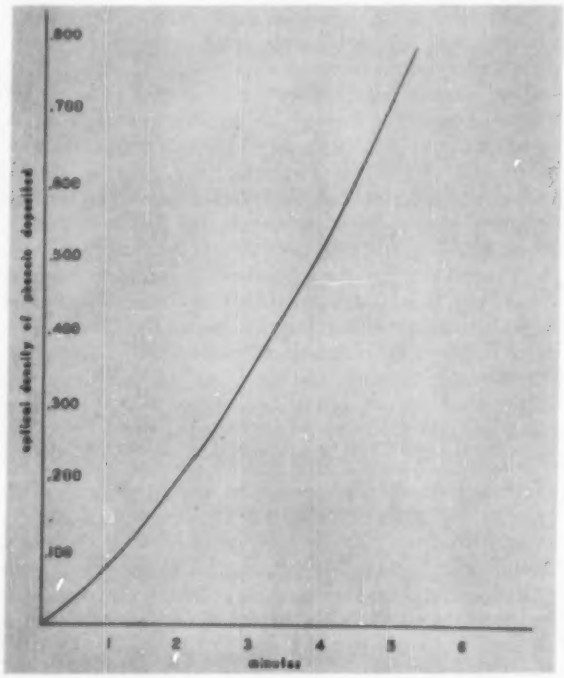

Figure 8. Effect of time upon smoke deposition.

processed bacon has a normal hue but a somewhat lighter shade than the conventionally processed product. During storage, the product processed in a conventional smokehouse tended to become definitely darker, especially in the red region of the spectrum. The laboratory product also became somewhat darker toward the red end of the spectrum, but very little change was observed in the other portion of the visible spectrum. These measurements indicate that color stability of the experimental product was as good, possibly better, than that of the commercial sample.

No recognizable difficulties were encountered in molding, slicing, or packaging the bellies produced by the experimental process. Laboratory facilities did not permit the processing of sufficient numbers of bellies to conduct a valid test on the yield of first grade sliced bacon. As far as could be established by laboratory tests, the bacon produced by electrostatic smoking and infrared heating had no greater tendency toward de-

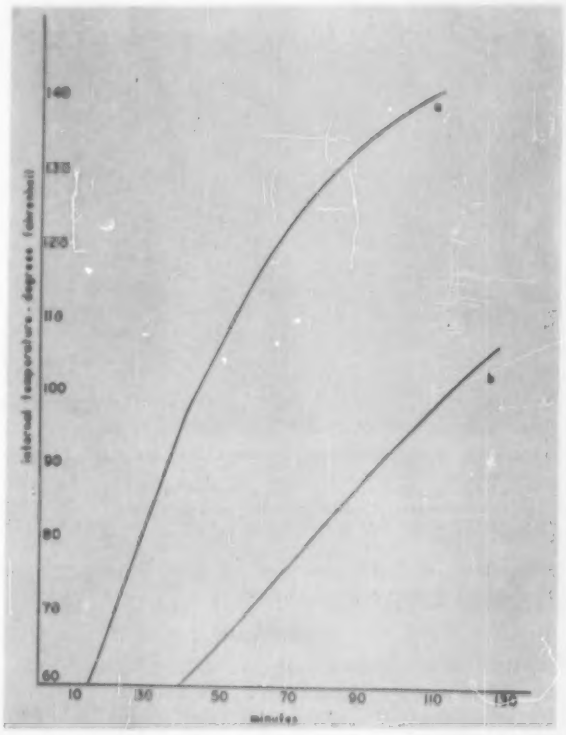

Figure 9. Effect of wet bulb temperature upon heating rates of bacon bellies.

a. 170° F. Dry bulb
145° F. Wet bulb

b. 170° F. Dry bulb
120° F. Wet bulb

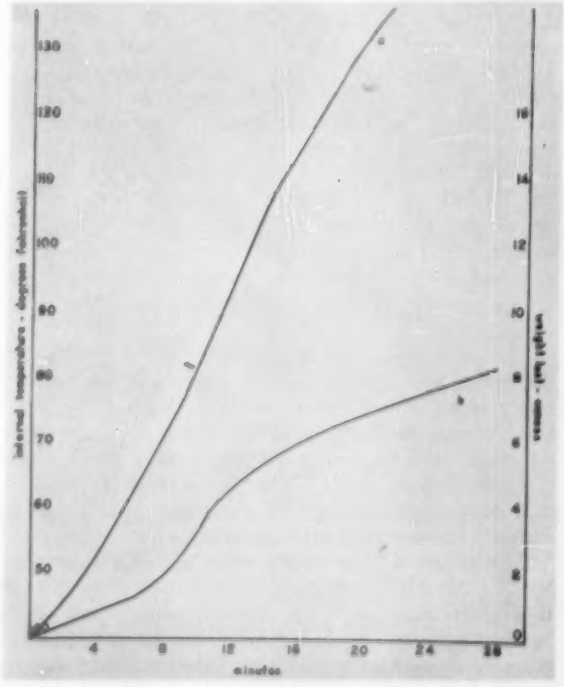

Figure 10. Effect of infrared heating upon internal temperature and weight loss.

a. Internal temperature of 9-lb. belly.
b. Weight loss from 9-lb. belly.

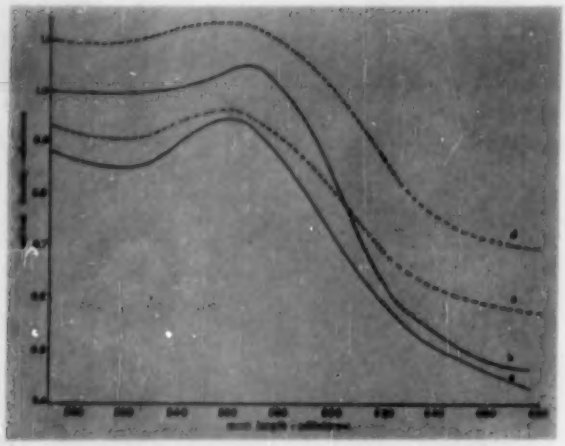

Figure 11. Spectrophotometric comparisons of internal color.
a. Infrared heated sample.
b. Control sample.
c. Infrared heated sample after 4 days storage in light.
d. Control sample after 4 days storage in light.

velopment of mold, rancidity or taint during storage than the regular commercial product.

DISCUSSION

Analysis of the design and operational features of the electrostatic system evaluated by the amount of phenolic materials deposited under controlled conditions, indicates that many of these features have a marked quantitative effect on smoke deposition. Several of these features, such as the distance between the ionizing wires and their respective plates (Figure 3), and smoke velocity (Figure 6), are represented as functions which pass through a maximum. Other features, such as distance between the ionizing wires and the sample (Figure 4), and the voltage on the ionizers (Figure 5), are continuous non-linear functions which are interpreted as indicating that maximum deposition of phenolic materials takes place at minimum ionizer distances and at maximum voltages. Both the distance and the voltage are limited by an electrical discharge between the ionizer and the sample. In practice, both are adjusted so that arcing occurs infrequently. There appears to be a direct linear relationship between deposition and smoke density (Figure 7) and duration of smoking (Figure 8).

The preceding relationships must be recognized in the design and operation of any electrostatic system for either batch or continuous smoking of meat. In addition, several of these variables which can be readily adjusted, such as ionizer voltage, smoke density, and possibly distance of the ionizer wires from the product, may be utilized to control the concentration of smoke deposited under production conditions.

In contrast to electrostatic smoking, experiments involving the infrared heating of bellies are more difficult to evaluate because of the many manifestations of the heating process. Unfortunately, it was not possible, with the equipment available, to obtain a valid measurement of the surface temperature developed under infrared irradiation. Difficulties inherent in measuring minimum internal temperature necessitated the performance of multiple measurements on many experimental bellies. The issue of restoring bellies to original weight appears to present no consequential problem. About three-fourths of the required weight loss can be attained by the infrared processing and the normal losses incurred during chilling, tempering, and slicing should restore the weight to the level prescribed by the government.

In view of the lack of basic information on the time-temperature requirements to insure normal color stability in finished bacon, more confidence was placed in measurements and observations made on the finished product than on the processing conditions. Whereas the finished slab bacon carried evidence of somewhat excessive surface heating, the sliced product was virtually indistinguishable from sliced bacon produced by the conventional process.

The laboratory processes for both electrostatic smoking and infrared heating and drying are readily translatable into a continuous process. As projected, such a process would start with a cured belly which would be conveyed through an infrared heating zone in which it would be brought to an internal temperature of nearly 120° F. From this zone, the belly would be moved into a continuous electrostatic smoking chamber designed on the basic principles as herein described. After smoking, the belly would pass into another heating zone to stabilize the smoke and to complete the heat processing. Up to this point, the belly would have been in process about 30 minutes instead of the 12 hours or more required by conventional procedures. After passing through the unit, the bacon would be chilled and subsequently processed in accordance with prevailing plant procedure.

SUMMARY

An analysis of the operation of conventional batch type smokehouses revealed the possibility of effecting a substantial reduction in handling expense by use of a continuous process. Examination of alternatives to the existing methods for smoking, heating, and drying bacon indicated the feasibility of electrostatic deposition of smoke and infrared heating and drying. A study of the design and operation of electrostatic smoking equipment led to the development of a laboratory model with which normal smoke flavor and odor are imparted to bacon within 3 minutes. The essential feature of the model is an ionizing section consisting of opposed plates with wire grids. Bacon, maintained at ground potential, is suspended between the ionizing plates. Smoke is channeled between the ionizing plates, which carry a potential of 40,000 volts, and thence is directed by electrostatic forces to the bacon. Smoke deposition, as measured by the amount of phenolic materials present, is influenced by the distance of wire grids from the ionizer plates, distance of the ionizers from the sample, smoke velocity, smoke density, ionizer voltage, and time. The last 3 variables can be effectively used to control the amount of smoke deposition. Tests performed at relative humidities of 45 and 80% indicate that humidity does not significantly alter the amount of smoke deposited. Smoke deposited by the electrostatic process tends to smear on the surface of the belly until stabilized by a mild heat treatment.

Examination of various procedures for heating bellies led to the adaption of rod type infrared heating units. By infrared radiation, an 8-10 pound belly cured by the injection of curing solution can be brought to an internal temperature of 120° F. or more within 25 minutes. Concurrently, the weight loss amounts to three-fourths of that required by government regulations.

By combining infrared heating and drying with electrostatic smoke deposition, cured bellies of the 8-10 pound class can be processed to bacon with 30 minutes. Sliced bacon thus prepared was evaluated for flavor, odor, frying characteristics, color, color retention, and microbiological and oxidative deterioration. By all these criteria the bacon was equivalent to, and not significantly different from, bacon prepared in conventional batch type smokehouses.

The procedures for infrared heating and electrostatic smoke deposition are readily translatable to continuous processing equipment.

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A Continuous Process for Smoked Meats. II. Equipment Design and Application[a]

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The design and operation of a commercial model for the continuous processing of smoked meats are described. The model is essentially a tunnel consisting of infrared heating zones and a chamber for electrostatic deposition of smoke. The operating characteristics for each section of the tunnel and the speed of the conveyor which moves the product through the tunnel must be established experimentally for each product. In the processing of bacon on a commercial scale, the continuous model effects a substantial reduction in handling costs in comparison with a conventional smokehouse. The model has been used for processing a number of products in addition to bacon. In the smoking of hams for canning, a processing shrink of less than 0.5% has been demonstrated. Other advantages of the equipment are discussed.

In an earlier paper, Hanley, Draudt, and Brockmann *(1)* have described the development of laboratory process and its application to cured bellies for the production of fully processed bacon in approximately 30 minutes. The process combines electrostatic smoke deposition with infrared heating and drying. The smoking process requires about 3 minutes for the development of normal smoke flavor. The infrared heating and drying require 25 minutes or more depending upon the weight class of bellies being processed. Laboratory tests, including appraisal of flavor, odor, color, color stability, frying characteristics, and resistance to deterioration, indicated that sliced bacon prepared by the electrostatic-infrared process was not significantly different from bacon prepared in conventional smokehouses.

Both the time requirements and the mechanical aspects of electrostatic smoke deposition and infrared heating operations, as developed in the laboratory, pointed to the feasibility of combining these operations into a continuous process for the production of bacon and other smoked meats. The primary advantage foreseen for a rapid continuous process for smoking meat is a substantial reduction in handling costs currently expended for loading and unloading conventional type smokehouses.

This paper is concerned with the design, operation and results obtained with a commercial scale continuous unit for the production of smoked meats. Although bacon is given primary consideration, the processing of other smoked meat items will be described.

DESIGN

Laboratory experimentation indicated that 8 to 10 lb. bellies require about 20 minutes of infrared heating, 3 to 4 minutes of electrostatic smoking, and a final 3 to 4 minutes of infrared heating. Translated into a continuous commercial production unit, this requires that bellies be conveyed through a sequence of heating, smoking and heating zones and that the conveyor speed and length of the respective zones be so related that the indicated retention time in each zone is maintained.

The continuous unit which was designed as a full scale production model can be represented as a tunnel approximately 70 feet long (Figure 1). The first 50 feet consists of 5 identical infrared sections, each approximately 10 feet long and 3 feet wide. These are followed by a smoking chamber, 10 feet long and 4 feet wide, and another infrared section. Each section is

[a] Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 13, 1955.

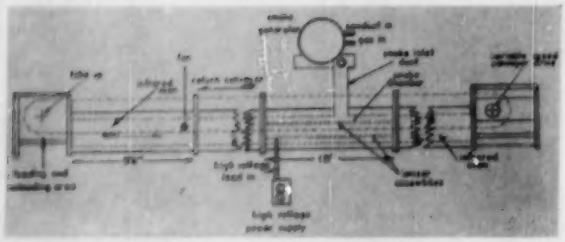

Figure 1. Top view of unit.

supported at the ends by an "A"-frame. In assembling the tunnel, the "A"-frames of contiguous sections are bolted together.

Running centrally, near the top of the tunnel, is a continuous cable conveyor supported by wheels which move on an "I"-beam track. The cable is fitted at intervals of one foot with brackets designed specially for bacon combs. These brackets prevent horizontal rotation of the combs. The conveyor is continuous and returns at the same level along the outside of the tunnel. The return conveyor is housed in a metal skirt. At the 180° turn at each end of the tunnel, the cable is carried by a large horizontal pulley. One pulley is mounted on a sliding track which is pulled by weights to maintain a constant tension on the conveyor cable. The other pulley is attached through a gear train to a variable speed drive by which the linear speed of the conveyor is controlled.

The outside walls of the heating sections are galvanized plates. These are separated by a two-inch air space from polished aluminum plates which serve as inner walls as well as reflectors for the heating elements. The bottom of each infrared section consists of removable stainless steel plates which slope into a trough running along one side of the heating section (Figure 3). Near the upper edge of the bottom plates is a

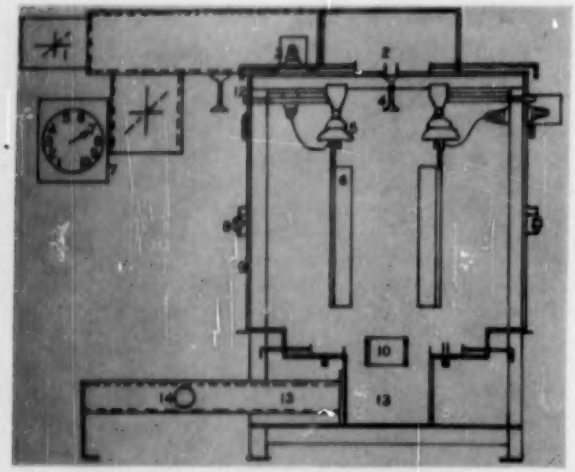

Figure 2. Cross section of smoking chamber:

1. Smoke exhaust duct louvers
2. Smoke exhaust duct
3. High voltage lead-in insulator
4. Conveyor rail
5. Insulators
6. Ionizer
7. Bailey smoke meter
8. Micro safety switch
9. Access doors
10. Grease trough
11. Smoke inlet louvers
12. Ionizer slide bars
13. Smoke inlet duct
14. Bolometer

water spray for flushing into the trough anything which drips from the meat. Troughs for each of the first 5 heating sections drain into a common header located 4 to 8 inches below the troughs.

Each heating section contains 6 Chromalox (E. L. Weigand & Co.) heating elements, 3 on each side, mounted horizontally in a plane parallel to the walls of the section. Each heating element resembles 2 hairpins with parallel bars 6 inches apart and extending 4.5 feet forward and backward from a waterproof electrical junction box mounted in the middle of each wall. Save for the distance required for each rod to make a 180° turn, each side wall carries 6 parallel rods spaced at vertical intervals of 6 inches. The minimum distance between rods on opposite walls of the heating section is 27 inches. When operating at full capacity, each heating element draws 4.6 kw. The heat output of each section is controlled over a range of 0 to 100% by a timing mechanism which operates on a 30-second cycle. Switches are provided for cutting out either side of a heating section.

Immediately following the series of 5 infrared heating sections is the smoking chamber (Figure 2). The external portion of this section is galvanized plate. The conveyor passes in a straight line from the heating sections through the central plane of the smoking chamber. Smoke from a commercial generator, located at the side of the chamber is introduced through a duct into the bottom of the chamber. The smoke is directed upward through adjustable louvers into the ionizing zone. This zone lies in the central plane of the smoking section between two

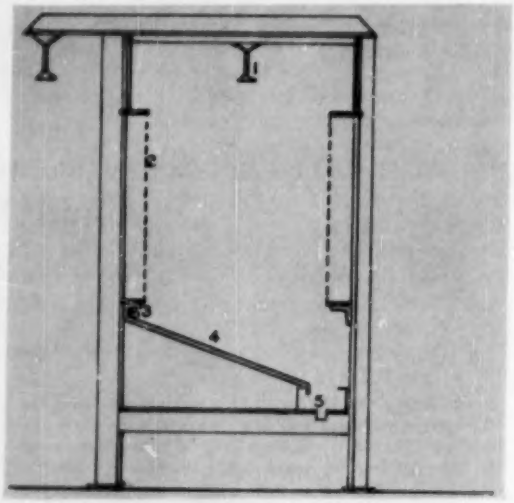

Figure 3. Cross section of infrared tunnel:

1. Conveyor rail
2. Infrared panel
3. Hot water line
4. Drip pans
5. Grease trough

rows of vertical ionizing plates which are suspended parallel to the path of the conveyor. Smoke which passes through this ionizing zone without being deposited on the meat is withdrawn, through adjustable louvers in the top of the chamber, into an exhaust duct from whence it is discharged to the atmosphere.

Inserted in opposite sides of the smoke duct leading to the chamber are a light source and a bolometer. The latter serves as the sensing element for a smoke density meter (Bailey).

A trough, approximately 6 inches wide, runs the length of the chamber at approximately the same level as the lower louvers. This trough collects drippings from the product and discharges them to a sewer.

Each ionizing unit is a stainless steel plate, 36 x 36 inches, with a bracket at the top and bottom. This supports a grid of 0.007-inch diameter tungsten wires in a plane 3.25 inches from the surface of the plate. Wires are spaced parallel on 3-inch centers. The ionizing plates are hung on 2 parallel rods, 3 plates to a rod. The end and center of each rod is suspended from insulators connected to movable rods perpendicular to the walls of the chamber. These sliding rods can be moved from the outside of the chamber, thereby changing the distance of the ionizers from the center line of the chamber.

Specially insulated cables connect the rods, which support the ionizers, with a high voltage rectifier and transformer (Trion), located a short distance from the chamber. Any potential between 0 and 60,000 volts can be imposed on the ionizers by adjusting a dial on the high voltage transformer.

In recognition of the inherent danger of high voltage equipment, several safety features have been incorporated into the design. The chassis, conveyor and all external parts of the smoking chamber are grounded. The high voltage source is equipped with a circuit breaker which responds to any sudden upsurge of current demand. The smoking chamber can be entered from either side by removing the side panels. To prevent access to the charged ionizing equipment, each panel is made to depress a microswitch. Removal of any panel releases its microswitch which breaks the circuit to the ionizers.

Following the smoking chamber is a single infrared heating section. This section is identical with the heating sections preceding the smoking chamber, save for the fact that the drain trough discharges to the sewer.

THE PROCESSING OF BACON

As in a conventional smokehouse, bacon processed in the continuous system must attain an internal temperature adequate for all heat induced changes. In addition, the characteristics associated with smoke, especially flavor and odor, must be controlled at a desired level. Heating and drying are controlled by the power input to the infrared heating sections and by conveyor speed. The amount of smoke deposition can be controlled by conveyor speed, smoke density, position of the louvers at the bottom of the smoking chamber, distance of the ionizers from the sample, and ionizer voltage. In practice, it has been found convenient to utilize conveyor speed for the partial control of heating and drying, to operate at a constant smoke density and to control smoke deposition primarily by ionizer voltage combined, when necessary, with changes in distance between the ionizers and the sample. In both preliminary tests and in commercial operation, skinless bellies injected with curing solution and handled in accordance with recognized commercial practice up to the point of transfer to the smokehouse, were used. After insertion of a comb, bellies were hung on the conveyor at the entrance to the first infrared section. It was found advantageous to retain bellies on the conveyor until they were returned to the loading station.

Operating conditions for each weight class of bellies up to 20 lbs. was established by tests on 15-20 bellies of each weight class. Conditions found most satisfactory were subsequently evaluated on lots of approximately 1500 lbs. The most formidable difficulty associated with the development of suitable operating conditions was the problem of product evaluation. No satisfactory procedure was devised for measuring the surface or internal temperature of bellies within the tunnel. By insertion of thermometers into the bacon leaving the tunnel, heating characteristics for a given set of conditions were observed. Weight loss in process was determined by weighing a number of bellies before and after processing. Whereas such observations were adequate for the identification of grossly unsatisfactory conditions, further observations were necessary to establish satisfactory operation. A minimum of one day, often two, was required for chilling and tempering the finished product prior to slicing. Special attention was directed to the yield of first grade bacon because previous observations indicated that bacon subjected to infrared heating tended to pull apart during slicing. To improve this slicing difficulty, the fat side of the bellies was subjected to less infrared heating than the lean side. Flavor, odor, and color were evaluated immediately after slicing and again after one or two weeks storage under simulated merchandising conditions. Bacon prepared in a conventional smokehouse was used as a reference standard. Operating specifications developed for the continuous processing of bellies are summarized in Table 1.

TABLE 1

Operating specifications[1] for continuous processing of bacon

Weight class bellies, pounds	Conveyor speed ft./min.
8-10	2.6
10-12	2.3
12-14	2.0
14-16	1.7
16-18	1.4
18-20	1.1

Heating section	Heater settings, % full power	
	fat side	lean side
1st	0	100
2nd	90	90
3rd	90	90
4th	0	100
5th	90	90
Final	100	100

OTHER OPERATING FACTORS AND REQUIREMENTS

Wt. gain belly from injection of cure	10% maximum
Time between injection and processing	24 hrs. minimum
Temperature of belly entering system	40° F. minimum
Internal temperature processed belly	115° F. minimum
Smoke density, Bailey meter units	80
Distance between ionizer and product	4 inches
Potential on ionizers	30,000 volts, for weights up to 14 pounds 25,000 volts, for weights above 14 pounds
Weight loss in process	7% minimum

[1] Unless otherwise indicated, values apply to all weight classes.

Bacon processed according to the specifications listed in Table 1 is virtually indistinguishable from bacon produced in conventional smokehouses in all properties, save for a frangible fat surface. This dissimilarity is not recognizable in the sliced product. Table 1 indicates that the bellies are oriented on the conveyor with the fat side toward the non-operating heaters. There seems to be no marked difference whether the comb is inserted in the shoulder or flank end of the belly; however, better results are obtained if the thicker end of a belly is at the top.

In operating at a conveyor speed of 2.6 feet per minute—the maximum speed indicated in Table 1—only one man is needed to insert combs into bellies, hang them on the conveyor, remove processed bellies from the conveyor and hang finished bacon on a truck for transfer to a chill room. The equipment has been used for extended periods of time to process 7,550 lbs. of bacon bellies per day. Such large scale tests have provided an insight into the economic aspects of the process as well as commercial acceptance of the finished product. The economic picture is summarized in Table 2.

It should be pointed out that to obtain slicing yields as indicated in Table 2 continuous process bacon must be subjected to carefully controlled conditions prior to slicing. The capacity figures given in Table 2 indicate that one continuous system, as here described, is equivalent to more than 3 conventional type smokehouses.

Most conspicuous advantage of the continuous process is the decreased handling cost.

Many tons of continuous process bacon have been sliced, packaged (each package bearing a special code designation), and distributed as conventionally processed product. No complaints, which could be related to the process, were received and there was no evidence that retailers or ultimate consumers recognized the product as being different from conventionally processed bacon. This confirms the laboratory evaluation that sliced bacon from the continuous process is indistinguishable from that produced in conventional smokehouses.

TABLE 2

Economic comparison between continuous and conventional processes for bacon

	Continuous Process	Conventional Smokehouse
Capacity	1500 lbs./hr.[1]	460 lbs./hr.[2]
Shrink	7%[3]	8%[3]
Utility cost	$0.09/cwt.	about $0.01/cwt.
Labor cost	$0.296/cwt.[4]	$0.679/cwt.[4]
Slicing yield (as first grade product)	82-86%	83-85%

[1] Virtually constant for bellies up to 20 pounds.
[2] Based on 13 hr. batch cycle for 12 to 14 lb. bellies.
[3] Does not include weight losses between injection and processing or during chilling and tempering.
[4] Includes cost of moving product to and from smoking area, all work performed on product and cleaning all equipment. (Based on labor cost of Nov. 1954).

PROCESSING OF OTHER MEAT PRODUCTS

Hams and picnics for canning, boiled ham, Canadian bacon, hams, picnics, jowls, plantation squares, pastrami, barbecued ribs, frankfurters, Vienna sausage, turkeys and cheese have been processed in the continuous system. Without exception, encouraging results have been obtained in the smoking operation. Less satisfactory results have been obtained with products of variable thickness which require heating to a definite temperature. On this basis, regular hams and picnics were not found suitable for processing with the existing installation. Frankfurters and Vienna sausage can be satisfactorily processed, but efficient operation demands an improved system for suspending these products during movement through the tunnel. Excellent results have been obtained with products which have been fully heat treated prior to smoking, such as boiled ham, or products which are heat treated after smoking, such as canned hams and picnics. In the case of hams for canning, processing losses amount to about 0.5% of the weight of the product entering the system.

DISCUSSION

The continuous system herein described can be operated by one man who, from a single station, performs all the operations incident to loading and unloading the conveyor. Additional labor is needed to deliver cured bellies to the loading station, to remove processed bellies from the loading station, and to refill the sawdust hopper on the smoke generator. Maintenance charges against the continuous equipment are low. Experience has shown that most operating delays are caused by a broken wire on an ionizer coming in contact with a grounded element. This necessitates a shut-down for about 5 minutes while the operator locates and replaces the offending wire. Sanitation-wise the system is easily maintained. No splattering from the product to the walls of the heating sections occurs, and as a consequence the reflector plates require only nominal attention. The plates at the bottom of the heating sections are cleaned with a detergent spray at intervals of 2 or 3 weeks. The interior of the smoking chamber requires cleaning with a detergent spray after 24 hours continuous operation; more frequent cleaning is required when cold products, such as hams for canning, are introduced into the smoking chamber. The safety features of the system, essentially a matter of design, have been mentioned previously.

In addition to the decreased handling expense as described for bacon and the negligible shrink as indicated for smoked canning hams, the continuous system for processing smoked meats offers several immediate or potential advantages. As is seen from Table 2, the capacity of the present continuous system is approximately equivalent to that of 3 conventional smokehouses. In view of the outlay and the installation cost for a conventional smokehouse, the continuous system represents a substantial savings in capital expenditure for equivalent processing capacity. Moreover, the space requirement of the continuous unit is far less than for conventional smokehouses of comparable capacity. Although the existing model utilizes about 80 linear feet of floor space, the tunnel can be made to conform to almost any available space.

In the processing of bacon, the electrostatic unit has a substantial reserve capacity for smoke deposition. It follows, therefore, that electrostatic smoke deposition can provide a far greater range of smoke flavor than is obtainable with existing smokehouses. This points to the possibility of producing distinctive smoked meat items which carry levels of smoke flavor in excess of existing products.

During the heating of bellies in the infrared units preceding the smoking chamber, a small amount of fat drips from the bellies. This fat is flushed into the troughs at the side of the heating sections from whence it can be recovered as pork fat. As yet, no data are available on the economics of this recovery.

From the standpoint of production scheduling, the continuous system offers definite advantages. Unlike a conventional smokehouse which is designed to process lots containing a fixed number of units, such as bellies of a particular weight class, the continuous system is adaptable to lots containing any number of units. Transition from bellies of one weight class to another or even one product to another requires no more than the time necessary for the preceding product to pass through the tunnel.

From the standpoint of microbiology, the continuous system and especially the electrostatic smoking unit, has a marked theoretical advantage. As indicated by Jensen *(2)*, the conventional smokehouse may serve as an incubator during the period preceding the development of a temperature unfavorable to bacterial growth. With the electrostatic process, a definite smoke can be at-

tained in such a short time and at such a low temperature that no change in bacterial population is evident. This aspect of electrostatic smoking is especially advantageous with smoked canned ham in which smoking temperatures sufficient to inhibit bacterial growth are likely to cause protein denaturation and hence difficulty in molding into the can. Even with products such as bacon a considerable concentration of salt is regarded as necessary to prevent taints of bacterial origin during smokehouse processing. The rapid attainment of an internal temperature of 120° F. with the infrared heating process virtually eliminates the possibility of bacterial taints and suggests the feasibility of preparing products of the bacon type without the addition of sodium chloride. This may have application in view of the fact that cured meats are contraindicated for more than 1,000,000 persons in this country who are currently on sodium restricted diets.

The attainment of a rapid and continuous process for smoking, heating and drying of bacon represents the elimination of one of the two or three barriers which currently prevent the development of a continuous process extending from the fractionation of a chilled hog carcass on the cutting floor to the removal of boxes of sliced bacon from the packaging area.

SUMMARY

The design features of a commercial size unit for the continuous processing of smoked meats are described. This unit consists of 6 infrared heating sections and an electrostatic smoking section aligned as a tunnel through which product is conveyed.

Operating conditions for the processing of various weight classes of cured bellies are described. After slicing, the bacon produced by the continuous unit is virtually indistinguishable from bacon produced in conventional smokehouses. Data obtained during the processing of 7500 lbs. of bacon per day indicate that the continuous operation effects a marked reduction in handling costs in comparison to conventional smokehouse processing.

In addition to bacon, a number of other products such as boiled ham, hams and picnics for canning, jowls, Canadian bacon, and picnics, regular ham and frankfurters have been processed in the continuous unit. In all cases, satisfactory levels of smoke deposition have been observed. The heating process, however, is not satisfactory for products of irregular thickness. For products which have been heat processed, such as boiled ham, and products which are subsequently heated by other methods, such as smoked hams for canning, the continuous unit offers a special advantage in that a desirable level of smoke flavor can be attained without inducing shrink in excess of 0.5%.

The continuous unit presents no special problems from the standpoints of maintenance or sanitation. It is probable that the capital expenditure for a continuous unit, of the type here described, is less than that for conventional smokehouses of equivalent capacity. Additional advantages for the continuous process are seen in its flexibility to production schedules and in the recovery of edible fat drippings prior to smoking. The fact that electrostatic smoke deposition is exceedingly rapid and can be performed without regard to temperature is of potential interest from the standpoint of meat microbiology.

Acknowledgment

The authors wish to acknowledge the contributions of Mr. Louis Crawford of the Allbright-Nell Co. toward the design and fabrication of the equipment on which this article is based.

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Pectic Enzymes in Wine Making[a,b]

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(Manuscript received June 21, 1955)

It is desirable that new wines be made clear and free of sediment as soon as possible after fermentation. Brilliantly clear wines are not only more attractive in appearance than the cloudy or hazy, but also, because early removal of suspended yeast cells and sediment forestalls certain undesirable changes in flavor, bouquet and stability, they are of higher quality. One means of hastening clearing is by the use of pectic enzymes. They have been used for many years in the clarification of apple juice, due largely to the pioneering research of Kertesz *(9)* and of Willaman and Kertesz *(24)* in this field. Use of pectic enzymes in wine making is a more recent application.

Preceding Research on Enzyme Treatment of Wine

Experiments on the clarification of wines by pectic enzymes in this laboratory were begun by Besone and Cruess *(5)* in 1936. It was found that enzyme treated wines cleared much sooner and could be filtered much more rapidly than the untreated. Further, there was no clouding of the clear enzyme treated wine during aging. Hickinbotham and Williams *(7)* in Australia published the results of their research in 1940. They found that use of a pectic enzyme hastened clearing of the un-

[a] Presented before the Fifteenth Annual Meeting of IFT, Columbus, Ohio, June 11, 1955.

[b] The authors gratefully acknowledge the support of the Rohm and Haas Company in making this investigation possible.

fermented juice as well as of the wine, facilitated pressing the crushed grapes, and increased the yield of white juice on pressing.

Cruess and Kilbuck *(6)* conducted commercial scale experiments in two wineries in 1946. When the enzyme was added to crushed white Semillon grapes and allowed to act over night before draining, the free run juice was increased 6.5% and the overall yield by 9%. Pressing was greatly facilitated. The lees (sediments) at the first racking (drawing off from the sediment soon after fermentation) were much more compact and therefore smaller in volume. The treated wines developed more rapidly during aging and at 6 months were superior in bouquet and flavor to the untreated.

Testa and Maveroff *(21)* in 1949 in Argentina reported on their experiments on pectic enzymes in wine making. Morrison *(16)* reported in 1950 that in laboratory experiments enzyme treated juices fermented with much less frothing than did the untreated, an observation confirmed in our experiments. Morrison also noted that enzyme treated red wines tended to lose some color in comparison with the untreated, an effect mentioned also by Reed *(21)* and observed by ourselves and others. (See also Huang's recent paper, *9*).

Kilbuck, Nussenbaum, and Cruess *(13)* in 1949 reported that a pectic enzyme on diatomaceous earth as a carrier was satisfactory in laboratory and winery experiments, provided the must was agitated long enough to dissolve the enzyme. As a carrier, dextrose is even more satisfactory, however, because it is soluble in the juice or water. Its use in this connection is not permitted at present in California.. Qualitative tests for the presence of oxidizing enzymes in several commercial pectic enzyme preparations were negative. The amount of enzyme required varied somewhat with grape variety. Liberation of methanol from the hydrolysis of pectin in several wines was found to be very small.

Recently Reed *(19, 20)* has published two useful reviews covering the action and production of pectic enzymes, recent investigations of their properties, and reports on their application in wine making. Among other data, he calls attention to those on some of the properties of the two principal enzymes that hydrolyze pectin; namely, polygalacturonase (PG) and pectin methyl esterase (PE). He notes the publication of Solms *et al. (22)* of Switzerland, Peynaud *(17)* of Bordeaux, and others on the pectin content of grapes and juices. Marsh and Pitman *(15)*, for example, found only 0.087 to 0.279 g. of pectic substances per 100 cc. of juice of Tokay, Zinfandel, and Alicante Bouschet grapes. He reviews the findings of Holden *(8)* and others, namely, that so-called fungal pectolytic enzyme preparations contain not only pectic enzymes but also an emulsin like enzyme (glucosidase), at least one protease, enzymes that can split cellulose and pentosans, and probably several other enzymes. Reed gives a list of 30 references on pectic enzymes, including one published in Russia.

Cruess and Alsberg *(4)* found that Pectinol, in use in 1931-34, contained a very active glucoside-splitting enzyme, using the bitter glucoside of the olive as the substrate.

Recently Huang *(9)* has studied the effect of certain fungal enzyme preparations on anthocyanin; the enzymes studied possessed rather marked anthocyanase activity, a finding of importance in connection with their use in making red wines.

EFFECT OF ENZYME ON SPECIFIC ASPECTS OF WINE MAKING

Effect of enzyme on yields of juice. In a typical case, ripe Muscat grapes of 25° Balling from Fresno, California, were crushed and stemmed and 250 p.p.m. of $NaHSO_3$ were added. They were divided into 6 lots. Pectinol-O was added in the amounts shown in Table 1, permitted to stand overnight, and then the grapes allowed to drain on a single layer of cheesecloth for about 2 hours. The free run juice was measured and the grapes were then pressed by hand.

Yields of both free run and press juice were markedly increased by the enzyme. The enzyme treated crushed grapes were much less viscous than the untreated and therefore were much more easily pressed. Apparently, under the conditions of this experiment, 0.5 g. of enzyme per 1000 g. was an adequate addition.

In another case, Muscats grown in a cooler climate in Contra Costa County, California, were treated in about the same manner as those reported in Table 1. They were of only 20° Balling and somewhat juicier than the preceding lot; consequently, yields were somewhat higher but the results were similar in other respects to those given in Table 1.

TABLE 1

Effect of pectic enzyme on yield of juice. Fresno. Muscat grapes. White

Lot	Pectinol-O grams per 1000 cc.	Free run cc. per 1000 grams of grapes	Press juice cc. per 1000 grams of grapes	Total cc.
M	None	534	123	657
1M	0.2	595	167	762
2M	0.3	611	164	775
3M	0.4	612	171	783
4M	0.5	629	137	766
5M	1.0	628	136	744

Similar results were obtained with Thompson seedless, Semillon, and Palomino grapes—all white varieties.

One lot of Muscat grapes was disintegrated in a Waring blender and one lot of red grapes of Valdepeñas, a red variety, was treated similarly. Four enzymes were added. The several lots were held overnight. The free run was then measured as previously mentioned.

The yields of free run were as follows for the disintegrated Muscat grapes expressed as cc. per 1000 g. of disintegrated grapes: untreated, 400 cc.; enzyme A, 420 cc.; enzyme B, 520 cc.; enzyme C, 540 cc. With the red grapes the yields were 472 cc., 488 cc., 511 cc., 577 cc. and 561 cc., respectively.

To 1000 g. lots of crushed and stemmed Folle blanche white grapes were added 4 different commercial pectic enzymes. The grapes were allowed to stand overnight and were then pressed by hand. The yields were: untreated, 780 cc.; enzyme A, 920 cc.; enzyme B, 915 cc. and enzyme C, 850 cc.*

In most, but not all, winery scale experiments yields were increased by the use of pectic enzymes.

The yield of red wines from crushed grapes treated with Pectinol and fermented with the skins was invariably larger in laboratory experiments and larger in most winery experiments, than from the untreated. For example, in one laboratory experiment the yield without use of the enzyme was 17,600 cc. from 20,000 g. of crushed grapes and from the same quantity of grapes treated with a pectic enzyme it was 19,200 cc., an increase of 8%. With Concord grapes the increase in yield was 14%. In an experiment with Mission grapes fermented on the skins, the volume of free run from the untreated

* A, B and C refer to three commercially produced enzyme preparations.

was 2100 cc. and from the enzyme treated, 2725 cc.; press wine yields were 1130 and 950 cc., respectively, and total yields, 3230 cc. for the untreated and 3675 cc. for the enzyme treated.

In another laboratory experiment of similar character, Pectinol-O gave an increase of 13.0% in total yield and 100-D an increase of 12.8%. In commercial tests differences in yield were usually less since winery presses are very much more powerful than our small hand press.

Effect on the rate of pressing. In a laboratory experiment, two lots of crushed white grapes were allowed to stand 3 hours, one without and one with Pectinol-O, 1 part per 1000. They were then pressed and the volumes of juice recorded at intervals (Table 2).

TABLE 2

Rate of pressing as affected by use of Pectinol-O

Interval	Volume of juice, untreated	Volume of juice, enzyme treated
	cc.	cc.
1st 0.5 min.	400	675
2nd 0.5 min.	100	225
2nd min.	90	215
3rd min.	90	205
4th min.	80	110
5th min.	60	110
6th min.	50	110
7th min.	50	110
8th min.	50	100
9th min.	50	100
10th min.	40	90
Total for period under observation	1,060 cc.	2,050 cc.

Pressing the enzyme treated grapes was much more rapid than it was for the untreated. When the free run and press juices were combined the enzyme treated grapes yielded 9.6% more juice than did the untreated.

Effect on rate of clearing. In many experiments fresh juice treated with pectic enzymes and allowed to stand overnight became very clear, whereas the untreated juices were still very cloudy. In the treated juices the sediments were very compact and of small volume; in the untreated they were fluffy and of large volume. This application of enzymes would be very useful in preparing juice for concentrating under vacuum to a heavy syrup or in the making of white wines.

Red and white table wines and the fortified dessert wines made with a pectic enzyme added to the juice in the case of white wines and to the crushed grapes in the case of the red, became clear much more rapidly in both laboratory experiments and commercial practice. Therefore, the treated wines could be racked (drawn off) from the yeast lees (sediment) much sooner than the untreated.

In a typical laboratory experiment untreated and treated lots of Muscat juice were fermented to 10-13° Balling and fortified with brandy to 20% alcohol. Within 4 days after fortification the enzyme treated wine was very clear and the untreated very cloudy. At 2 weeks the enzyme treated wine was brilliantly clear and the untreated was still cloudy. Similar results were obtained with unfortified white table wines made from Semillon, Palomino, Folle Blanche, Green Hungarian, Burger, Chenin Blanc, and Riesling varieties. Red wines made from Zinfandel, Valdepeñas, Carignane, Grenache, Alicante Bouschet, Barbera Beclan, and Cabernet sauvignon grapes cleared much more rapidly after fermentation on the skins with added Pectinol-O, 1 g. per 1000 g.

Crushed red grapes of Barbera, Valedepeñas, Alicante Bouschet, and Petite Sirah varieties were heated at 140-150° F. to extract the red color and were pressed. Some of the juice was fermented without addition of enzyme and some with Pectinol-O; and in addition small lots of the Barbera were fermented after addition of Rohm and Haas enzymes No. 48 and R-10 and of Takamine Laboratories' Pektizyme concentrate. The untreated wines failed to clear in 6 months' aging, whereas all of the enzyme treated wines became very clear to brilliantly clear in less than 2 months of aging.

In a winery scale test red grapes for making port wine were disintegrated in a Rietz disintegrator, flash heated to about 190° F., and cooled immediately. Most of the juice was treated with a pectic enzyme in accordance with the regular practice of the winery, but some was not treated. Both were partially fermented and fortified to about 20% alcohol content.[4]

The enzyme treated wine became clear very rapidly and is now of deeper red color than the untreated. The untreated is still cloudy although now more than two years old.

This experiment merely confirms similar data taken on a more extensive scale by Berg and Marsh *(2)* in 1949. They found the use of a pectic enzyme was necessary to attain satisfactory clearing of the new wine without use of a heavy clarification with Bentonite.

Effect on character of lees. As previously mentioned, pectic enzymes not only hasten clearing of the new wines but also cause the first lees or sediment to be much more compact and smaller in volume. Hence less wine is lost in the sediment and the wine can be racked in clearer condition than if untreated. These observations were confirmed in experiments and winery observations during the past 3 years.

Effect on amount of fining agent required. In many wineries new wines are fined (clarified) with Bentonite clay. [See Amerine and Joslyn *(1)*, or Cruess *(3)* for methods of preparing the clay and its application in the fining of wines.]

In a large winery near Madera, California, 1½ pounds of Pectinol-O was used in 1950 per 1000 gallons of crushed Muscat grapes. These were fermented to 14° Brix and the wine fortified to 20% alcohol, as Muscatel. It was found that only 1½ pounds of Bentonite per 1000 gallons was required to clarify the new wine, whereas 6-10 pounds per 1000 gallons was required for the untreated. Similar results were obtained in a large winery near Tulare, one near Modesto, another near Escalon, and in several other California wineries. Results were particularly striking with new dessert wines (fortified wines). The Bentonite requirement was reduced to 1½ to 2 pounds per 1000 gallons, compared with the 5-10 pounds usually required. When less Bentonite is used, the lees from the clarification are smaller in volume; therefore, less wine is lost in the sediment at racking after fining.

In laboratory experiments, results similar to those mentioned above were obtained. Thus in a recent experiment less than one-third as much Bentonite was required to clarify an enzyme treated new port wine, as for the untreated.

In another case as little as one pound of Bentonite was needed per 1000 gallons for clarifying the enzyme treated wine satisfactorily, whereas 3 pounds per 1000 gallons failed to clarify the untreated.

Use in heat extraction of color. Rahman and Joslyn *(17)* have stated recently that the optimum temperature range for fungal enzyme PG activity is 45-55° C. (113-131° F.), and that most of the activity is lost between 65-70° C. (149-158° F.). Reed *(10)* has given similar values. Kohn *et al. (13)* at Amherst determined the inactivation temperature of pectic enzymes used in clarifying fruit juices. Since the red color of grape skins "flows" quite rapidly at 125-145° F. (52-63° C.), experiments were conducted with crushed Valdepeñas grapes (a red wine variety) and with white Muscats. Three commercial enzyme preparations were added to small lots of the crushed grapes brought to and held at 52° C. (125° F.) for 1, 2 and 5 hours, 54.5° C. (130° F.) for 2 hours and at 140° F. for 3 hours. They were then drained, pressed, and the juices fermented with pure wine yeast. One enzyme, A, was used at the rate of 1 g. per 1000 g. of grapes, the others, being "10X" concentrates, were added at the rate of 0.1 g. per 1000 g. All the enzyme treated grapes drained rapidly and pressed very readily; all "slipperyness" had disappeared. Within 3 hours after pressing the enzyme treated juices had settled clear and after fermentation became clear within 24 hours. The untreated juices and wines remained cloudy. Color extraction was good at the 3 temperatures, even at 52° C. (125° F.) for one hour.

After fermentation, color comparisons were made, using the Dubosc colorimeter. In all cases the enzyme treated samples

[4] We are greatly indebted to the Italian-Swiss Colony Winery of Clovis, California, and to Mr. Eli Skofis of that plant for conducting this experiment.

had about twice as much red color as those in which enzymes were not used. The depth of color of the 3 enzyme treated lots from each run was approximately equal. The tint of the enzyme treated samples was normal and similar to that of the untreated.

The enzyme treated Muscat (white) samples were of about the same depth of color and tint as the untreated, all being medium amber in color. At present Muscat grapes are not heat extracted commercially but if heat extraction were adopted in winery practice the use of a pectic enzyme would seem advantageous.

In the extraction of red juice for concentrating under vacuum to a heavy syrup used in "balancing" of sweet wines, a winery near Fresno, California, heats the crushed grapes to 145° F. (63° C.) with 2 pounds of Pectinol-O per ton of crushed grapes. About 6 hours elapse from beginning of crushing a given lot of grapes to beginning of drawing off the heat extracted juice. The enzyme is still active; to inactivate it the juice is flash heated to about 330° F. in a closed system and immediately cooled to about 240° F., at which temperature it enters a continuous vacuum evaporator. Flash heating destroys the enzyme. The winery operator believes that the red color of the concentrate is more stable in storage if the enzyme is no longer active. The viscosity of the enzyme treated concentrate is much lower than of the untreated and therefore much more easily handled; also it is much clearer.

We prepared in November, 1954, three white concentrates from juice clarified with three enzymes and one untreated lot and, similarly, the same number of red concentrates. All were concentrated in glass under high vacuum to 69-71° Brix, and stored at room temperature. At the present time (May 15, 1955) the enzyme treated concentrates are very clear; the untreated are cloudy. All are of good color and flavor.

Effect on rate of aging. As reported in previous papers from this laboratory *(5, 6, 13)*, treatment of the juice or crushed grapes with pectic enzymes markedly hastens aging of new wines. On this account care must be taken not to age the enzyme treated wines too long before bottling. Insofar as we have been able to judge by tasting, the enzyme treated wines are ready to bottle in less than one-half the aging period required for the untreated. Over-aging may result in loss of red color and deterioration (flatness) of flavor and bouquet, well known characteristics of all overaged wines, enzymes treated or not. These previous observations were confirmed during the past three years.

Destruction of enzyme by heat in wine. In an earlier section the destruction of the enzyme by heat in the production of grape concentrate was mentioned. In several laboratory experiments enzyme treated wines or fermenting juices were flash pasteurized at several intervals after beginning of fermentation in order to observe the approximate length of time required for satisfactory clarification at room temperature and if possible the effect of early elimination of the enzyme on subsequent behavior of the new wine.

In one experiment crushed, fermenting Carignane grapes, treated with 1 g. of Pectinol-O per 1000 g. were heated after 2 days fermentation to 180° F. (82° C.), cooled and inoculated with yeast; another lot was similarly treated at 6 days. Two other enzyme treated lots and one untreated were not heated. During subsequent aging all lots except the untreated cleared rapidly, indicating that the enzyme had done its work in 2 days or less. A similar experiment with white juice gave like results. To date all of the enzyme treated wines are similar to the untreated in color.

Color of white wines. There has been considerable interest among wine makers and investigators on the effect, if any, of pectic enzyme preparations on the color of white wines.

During the past several years we have compared the color of many enzyme treated white wines with those of the untreated. In observations made in March 1953 on experimental white and several commercially made white wines, a total of 53 wines, it was found that 13 of the enzyme treated wines were slightly darker than the untreated. That is, they were yellower or more amber in color. On the other hand, 32 of the treated wines were lighter in color than the untreated and 8 were of approximately the same depth of color as the untreated. In each experiment one lot was untreated and usually three or more lots were enzyme treated. Therefore, the enzyme treated lots outnumbered the untreated, a fact that must be kept in mind in any comparison.

Examination of 34 white wines made in the laboratory in 1953 and 1954 and representing several varieties gave results similar to those reported in the preceding paragraph. If the enzyme treatment had any appreciable effect on the color, one would expect a larger proportion of the treated wines to be of deeper color than the untreated. The differences observed could probably have been due to conditions other than enzyme action.

When the enzymes were allowed to act on crushed white grapes, they usually gave juices and wines of deeper color than the untreated because they broke down the grape tissues and increased extraction of color from the skins. In a 1954 season laboratory experiment, 3 different enzyme preparations used with the crushed white grapes gave wines of deeper color than the untreated. In another experiment with crushed Muscat grapes the wine from the enzyme treated was approximately twice as deep in color as the untreated; both having been fermented for 48 hours on the skins. In several winery experiments it was found that the enzyme acting on the skins extracted sufficient color to make the enzyme treated wines darker, especially after aging. Therefore, if white wines of light color are desired, the enzyme should be added to the juice, not to the crushed grapes.

Color of red wines. As noted in the introduction, Huang *(9)* has observed anthocyanase activity in certain fungal enzymes, and on that account their use in wine making might be expected to have some effect on red wine color.

In one experiment eleven red wines made in this laboratory with pectic enzymes were slightly lighter in color than the untreated, except in one case where the color was only about one-half that of the untreated; 13 of the treated were equal to, or deeper in color than, the untreated. The difference in flavor of the enzyme treated was greater in the heat extracted samples.

In most cases the color of the enzyme treated wines aged more rapidly than that of the check lots; that is, they lost their purple color sooner and developed the plain red to brick red color of aged wines sooner.

Several pectic enzymes were compared in 1953 and 1954 in respect to their effect on the color of red wines. With Alicante Bouschet grapes fermented on the skins in 1954, one enzyme gave a red wine of lighter color than the untreated and two recently developed enzymes gave red wines of slightly deeper color than that of the untreated. Similar results were obtained with the heat etxracted juice. Petite Sirah grapes of the 1954 season were treated with various amounts of the 2 newer enzymes previously mentioned. The resulting enzyme treated red wines were in 10 cases equal to the untreated in color and in only one case lighter in color. In this instance (lighter color) 10 times the normal "dose" of enzyme was used in order to intensify anthocyanase action.

The enzymes were also used experimentally during heat extraction of the juice at 125° F., 130° F., and 140° F. The juices were then fermented and the resulting wines compared in respect to color. The wines made from puices in which enzymes were used during extraction were in all cases of deeper red color than the untreated. They have not been stored long enough to determine relative stability of the color of the several lots.

In several earlier experiments (using the enzymes available in 1940-1950) deterioration of the red color to brown in several samples occurred during storage at 85° F. Incubation of 1954 samples has not been sufficiently prolonged to ascertain whether a similar change will occur with the two more recently developed enzymes. The producer of one of these enzymes states that it is much lower in anthocyanase content than enzyme preparations of former years. In general our observations tend to confirm that statement.

A winery of medium size, several years ago treated all of its crushed red grapes with a pectic enzyme. All wines were of very satisfactory color and quality. A sample of Zinfandel, now 3½ years old, so treated was examined at the winery recently and found to be of excellent flavor, bouquet, and color. All of the other treated red wines of that year had been bottled and sold.

A very large winery in Sonoma County, California, treated all of its crushed red wine grapes with a pectic enzyme during several vintages; 1½ to 2 pounds of the enzyme preparation being used per ton. Results were excellent. Color, flavor, and bouquet of the aged wines were normal. We have tasted and have stored a number of the enzyme treated wines from this plant. All have stored well with no breaking of the color or sedimentation.

Two large California wineries are using the enzyme at present on most of their red wines with very satisfactory results.

Role of SO_2. As previously reported Cruess and Besone *(5)* and Reed *(19)* reported that the enzyme is not affected by the concentrations of SO_2 normally used in wine making. In an experiment conducted by O'Neal in this laboratory mute (juice used for sweetening Sauterne wines) was treated with P-ectinol-O and preserved with about 1,000 p.p.m. of SO_2. It became brilliantly clear and kept well.

White wines were made in our experiments with and without a pectic enzyme and with concentrations of SO_2 ranging from none to 300 p.p.m. In another experiment SO_2 was added to the new wines during aging. In most cases the SO_2, if maintained at 125 to 200 p.p.m., effectively checked deepening of the color of both the untreated and the treated wines.

Stability. Wines are expected to remain clear and more or less free of sediment after bottling; that is, they should be stable. Several wineries have reported to us that enzyme treatment has a very pronounced effect in promoting heat stability of wines. One found that when a pectic enzyme was used in making its wines it was not necessary to heat stabilize them by pasteurization, but since discountinuing enzyme use their wines must be stabilized by flash pasteurizing at a rather high temperature. Kilbuck *et al. (13)* reported in 1951 that a number of enzyme treated and corresponding untreated wines were stored at 0° F. (actually frozen) for several days and thawed to test stability to cold and other samples were incubated at 131° F. and then cooled to observe heat stability. No great difference in stability was observed between the untreated and the enzyme treated wines in these tests.

More recently, several enzyme treated and correspoinding untreated samples were frozen at 0° F. for several days and other samples were heated to 212° F. and allowed to cool in air. Wines made from white juice extracted at 125° F. and 140° F. with and without enzymes were all stable at 0° F.; similarly for red wines made in like manner and for 4 samples not heat extracted but fermented on the skins. Fourteen wines made by extraction at 140° F. were all stable including the check lots. The untreated white wines made from juice extracted at 125° F. for 1, 2 and 5 hours became cloudy at 212° F., whereas the 9 enzyme treated wines remained clear. Eight red wines made from juice extracted at 125° F. and at 140° F. remained clear after heating at 212° F.; these included 6 enzyme treated and two checks. Of 4 red wines made from the same lot of grapes but not heat extracted the untreated and those treated with the 2 recent enzymes became hazy at 212° F.; that treated with enzyme A (an enzyme used extensively in the past) did not become hazy at 212° F.

In another comparison of new wines of the Folle Blanche variety 3 enzyme treated samples became cloudy at 212° F., and the untreated much more so. Stability of all was better at 0° F. than at 212° F., the only sediment being cream of tartar crystals at 0° F. Results with white wines made from Muscat grapes in the laboratory were similar except that clouding of the enzyme treated wines at 212° F. was very slight and that of the untreated very severe.

Effect of added ascorbic acid. Ascorbic acid is a powerful reducing agent and is known to retard browning of citrus juices. In several experiments in previous years and again in 1954 it was added in amounts ranging from 50 to 200 mgms. per 100 cc. of white wine. For a few weeks under incubation at 85° F. the ascorbic acid treated wines remained light in color and of normal flavor but within a year all had darkened, several becoming almost black in color. The untreated check remained light in color. The purpose of the experiment had been to ascertain whether ascorbic acid could be used to replace SO_2 as an anti-oxidant or anti-browning agent in white wines. Evidently it is not suitable for that purpose.

Effect on filtration. Wineries that have used pectic enzymes have stated that the enzyme treated wines can be filtered much more readily than the untreated. In one case a producer of Muscatel wines reported that he was able to filter 35,000 gallons of enzyme treated wine with one setting of his plate and frame filter. With untreated wine he would have had to break down the filter and reset it at least once, probably more times, during filtration.

In a recent laboratory experiment enzyme treated and untreated new wines made in the laboratory were filtered into graduated cylinders, using small glass funnels and folded analytical quality white filter paper; typical results were as follows:

In these and in other experiments, the enzyme treated wines filtered more rapidly than the untreated and also did not clog the filter so soon; note the second Muscat test.

TABLE 3

Effect of enzyme treatment on filtration rate

Wine	Time in minutes	Filtrate	
		Untreated wine	Treated wine
		cc.	cc.
Palomino (white)	1	38	55
Palomino (white)	2	64	95
Muscat			
1st lot	1	22	25
1st lot	2	32	37
1st lot	3	43	47
1st lot	4	48	57
1st lot	5	55	65
1st lot	7	70	85
Muscat			
2nd lot	1	30	30
2nd lot	2	48	54
2nd lot	3	63	67
2nd lot	4	75	82
2nd lot	5	82	94
2nd lot	6	85	104

Composition of the wines. Analyses of a considerable number of commercially produced and laboratory made wines disclosed no significant differences in total acidity, alcohol, volatile acid and residual sugar content. Determination of volatile ester content indicated a slightly greater content of this constituent in the enzyme treated wines.

Nitrogenous constituents. Tchelistcheff and Heitz *(23)* reported in 1954 that treatment with a pectic enzyme under winery conditions, lowered the nitrogen content of the juice with resultant greater stability of the wine. For example the untreated Semillon wine contained 0.10% total N whereas those treated with 2 pounds and 3 pounds of enzyme preparation per 1,000 gallons had 0.08 and 0.04% total N respectively. Berg and Marsh *(2)* also noted a decrease in total N content of pectic enzyme treated heat extracted red juice and the resulting wine. They also observed a decrease in alcohol precipitable material. All of which might indicate a decrease in protein content.

In our experiments we were unable to demonstrate any appreciable change in N content of the wines, in their total amino acid content, or in the alcohol precipitable material. This was due, perhaps, to the fact that the wines we used for analysis were made on a very small scale and possibly had not had sufficient time before analysis to allow deposition of enzyme coagulated materials.

We added 4 enzymes to a dilute solution, about 0.5%, of egg white in water and incubated at 110° F. The untreated sample remained hazy and free of sediment; three of the enzyme treated samples developed rather coarse clots of albumin that settled out and the fourth a rather fine grained clot. All of the enzyme treated samples cleared appreciably in 24 hours at 110° F. Evidently the enzymes used carry one or more proteases. Reed *(19)* has also mentioned this property of fungal enzyme preparations.

The enzymes were added to a 3% solution of high quality gelatin in white wine and incubated at 110° F. for 4 days. The samples were then chilled overnight at 48° F., to see if enzyme action had been sufficient to prevent jelly formation. The untreated sample and one treated with one of the "new" enzymes available for the first time in 1954 were jellied (stiff jellies) whereas the samples treated with 3 other enzymes remained liquid, indicating quite extensive protease action.

Effect on methanol content of wine. During the 1953-54 season, data in addition to that previously reported in 1949 by Kilbuck, Nussenbaum, and Cruess *(13)* was obtained on the effect of enzyme treatment on the methyl alcohol content of wines. Since pectic enzymes liberate some methyl alcohol from pectin by hydrolysis of the OCH_3 groups an increase in MeOH content could be expected when such an enzyme is used in wine making.

In one case untreated Zinfandel red wines made in 1953 by fermentation on the skins contained 0.019% of MeOH per 100 cc.; two in which Pectinol-O was used contained 0.023 and 0.020% and two made with pectic enzyme 100-D, 0.021 and .026%. Untreated Semillon white wines contained 0.005, 0.009 and 0.005% MeOH, the Pectinol-O treated 0.014 and 0.023% and 100-D treated 0.021 and 0.026%.

Untreated Muscat wine fermented on the skins contained 0.093% of MeOH, that treated with 100-D 0.108%. Those made from the juice only contained .076 and 0.079%, respectively.

Data obtained with another picking of Zinfandel red wine grapes, Mission variety and Concord grapes (red) were similar to that reported above. In all cases the methanol content was far below the legal limit of 0.35%.

Effect of added acid. In an experiment with Palomino grape juice 0.5 g. citric acid was added to two lots and 1.0 g. per 1000 cc. to 3 other lots. In 3 lots Pectinol-O was used and in two, no enzyme. All five of these wines were much lighter in color than the non-acidified check lots, as measured by colorimeter and as judged by eye.

In another experiment various amounts of galacturonic acid were added with and without enzyme to new white wine to ascertain whether this acid would promote darkening of the color. On aging, the acidified samples were markedly lighter in color than the untreated.

These results might indicate that the occasional deeper color of white wines may be due to over-ripeness of the grapes with consequent low acidity rather than to enzyme action. Wine producers believe this to be an important factor.

USE OF ENZYMES BY WINERIES

During the 1954 season it is reported that 27 wineries used the pectic enzymes of one producer. Several used them in the production of berry wines as well as of grape wines. Reed *(20)* states that most producers of fruit and berry wines as well as Concord grape wines in the Pacific Northwest and East of the Mississippi use pectic enzymes. Most California commercial users of pectic enzymes state that results have been satisfactory.[a]

Use in fruit wines. Several producers of berry wines in California use pectic enzymes. As previously mentioned Reed *(20)* reports their application in most fruit wine establishments in the Pacific Northwest. Yang, Thomas, and Wiegand *(26)* of Oregon State College, conducted experiments in a commercial winery on the application of pectic enzymes in the production of loganberry, blackberry, currant and concord grape wines. One pound of Pectinol-M was used per ton of fruit before fermentation. Increases of 5.18 to 10.44% in yield of wines were obtained by use of the enzyme.

In our experiments fruit wines were prepared in the laboratory[f] with and without enzyme treatment from loganberries, boysenberries, blackberries, peaches, elderberries, apple juice, pears, plums, dates, fresh prunes, figs, orange juice, and grapefruit juice. The enzymes greatly hastened clearing of the wines and markedly improved pressability when added to the crushed fruits, notably pears, peaches, plums and figs. In fact, practically no juice was obtained from peaches and figs unless the enzyme (Pectinol-O) was used.

Addition of sugar was necessary in most cases in order to give wines of adequate alcohol content (10-12%). With most of these fruits a larger quantity of the enzyme, usually 1 to 2 g. per 1,000 g. or 1,000 cc., was required than for grapes. Two grams per 1,000 cc. was necessary for the Valencia orange wine in order to secure satisfactory clarification. Berry wines were made in two ways: (a) by fermentation of the crushed berries and (b) by fermentation of the heat extracted juice. Loganberry, boysenberry, red plum, and blackberry juices obtained by heat extraction were diluted with water and sweetened with cane sugar in order to obtain a pleasing balance between final alcohol content and acidity. Figs, ripe peaches, and ripe prunes required acidification. Elderberries were crushed and an equal volume of water and 0.5% of citric acid were added. Sugar was added also to give a juice of about 22° Brix. A flavorful wine of very deep color was obtained.

Some of the dry wine of several varieties of fruit was sweetened with cane sugar to about 10° Brix and fortified with grape brandy to 18-20% alcohol content for use as dessert wines or liqueurs.

In general the enzymes gave excellent results in both the dry and the fortified sweet types of fruit wines.

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[a] The following extract from a letter from a large producer illustrates this:

"Our use of Pectinol during the 1950 vintage produced wines of amazing stability characteristics. I am listing below the points at which stability effects became evident.

1. High degree of clearness before fermening.
2. High degree of clearness during fermenting.
3. High degree of clearness after fermentation.
4. Small amount of sediment after fermentation.
5. High degree of clearness after bentoniting.
6. Small amount of tartrates and other solids which deposit in the unrefrigerated wines.
7. Small amount of tartrates and other sediment which deposit in the refrigerated wines so processed.
8. Remarkable stability at 18° F. in our test box.
9. Remarkable stability at 140° F.
10. Striking light color. Our use of the enzyme during the 1950 vintage was in 248,000 gallons of dry Palomino, which in turn was harvested in September."

Several bottles of the Palomino wine mentioned by this writer have been examined. The wine is brilliant, of very light color, and of pleasing flavor and bouquet. It is free of sediment. (This wine is now more than three years old.)

Operators of another large winery reported as follows:

"We have used Pectinol-O and 100-D pectic enzymes in the production of dry wines and have not noted any discoloration of the white wines due to its presence. The relative maturity of grapes may have something to do with this behavior in wine. In this area the use of over-ripe grapes is not conducive to the production of acceptable wines, therefore, we try to pick the grapes at what we consider proper maturity and they receive the enzyme treatment.

This company has used pectic enzymes for the past several years."

[f] Most of the fruit wine experiments were made by F. Nussenbaum.

SUMMARY

During the past several years studies have been continued on the use of pectic enzymes in the production of wines made from grapes and fruits. Both laboratory and winery scale experiments and observations were made on grape wines. Yields were consistently greater in laboratory scale experiments when pectic enzymes were used. In winery tests, yields were usually but not always greater when a pectic enzyme was used. During the past season four commercially produced pectic enzyme preparations were used experimentally; two had been studied previously, two were new. All clarified the experimental wines satisfactorily. One of the new enzymes was tested under winery conditions and proved satisfactory.

Rate of pressing of crushed unfermented grapes was more rapid if treated for several hours with a pectic enzyme. The lees at first racking were more compact and of smaller volume in laboratory experiments and in most winery tests when a pectic enzyme was used. Very much less bentonite was required to fine (clarify) enzyme treated wines; both in laboratory experiments and in commercial practice. Four commercial enzyme preparations withstood 140° F. satisfactorily in the heat extraction of crushed red grapes and greatly improved pressability of the crushed grapes and rate of clearing of the juice and wine. As previously reported it was confirmed that enzyme treatment hastened aging of the new wines.

Color of enzyme treated white wines made without action of enzymes on crushed grapes was in some cases the same as that of the untreated; in a few cases it was yellower or more amber in color than the untreated. In a like number of cases the untreated wines were of deeper color than the treated. When used in red wine making the color of the enzyme treated wines fermented on the skins was in the majority of cases somewhat lighter than the untreated, due according to Reed, to presence of an anthocyanase. Red wines made with pectic enzymes by several wineries over a period of several years have been of very satisfactory and stable color.

Enzyme treated wines were on the average somewhat more "heat stable" than the untreated and of about the same stability as the untreated at 0° F. One large winery reported very marked improvement in stability due to enzyme treatment.

Other findings of interest may be listed as follows: Ascorbic acid added to white untreated and enzyme treated white wines caused severe darkening on incubation at 85° F. Enzyme treated wines filtered more rapidly than the untreated. Methanol content was increased only very slightly by enzyme treatment, the final MeOH content being far below the legal limit. Acidifying the must before fermentation gave wines of lighter color. Maintenance of an adequate level of SO_2 prevented darkening (deepening of the color) of experimental wines, whether enzyme treated or not.

Use of pectic enzymes has proven very satisfactory in most wineries that have used them. Our experiments with the use of pectic enzymes in making fruit wines confirmed those of Yang, Thomas and Wiegand of Oregon. Results were very satisfactory.

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Water Absorption During Reconstitution of Dehydrated Fruits and Vegetables*

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Effects of two variables were noted on rate and amount of water absorbed during reconstitution of certain dehydrated fruits and vegetables. Increase in initial temperature of water resulted in slight increase in percent water absorbed in most cases, especially in the early stages of reconstitution. Increase in ratio of water to product resulted in a similar tendency. Taste panel ratings showed that within the limits of amounts of water absorbed in these experiments, the percent absorption had little effect in most cases on the palatability of the reconstituted product.

In spite of the fact that numerous directions for rehydrating and cooking fruits and vegetables may be found in special bulletins *(6, 7)*, in food journals *(1, 4)*, and in recommendations from manufacturers, extensive studies concerning the problem are rather scarce, and information necessary for establishing standard methods is incomplete. As a result, procedures recommended often differ greatly from one source to another, even for the same type of product. Since a product may vary from poor to excellent according to the method of reconstitution, the importance of optimum conditions for reconstituting dehydrated products is evident.

Factors that may affect the quality of dehydrated fruits and vegetables during reconstitution are many: period of soaking (if any), temperature of water, ratio of water to product, rate of heating, and length of cooking period are some of the more important examples. Only limited work concerning these factors is reported in the literature and the findings are sometimes controversial. For instance, Davis and Howard *(2)* recommend soaking of carrots at room temperature before boiling in order to obtain higher percentage of water absorption and better finished products. Fenton and Gifft *(3)* on the other hand, reported no appreciable difference in the amount of water absorbed in cabbage or potatoes according to whether or not the products were soaked. Working with other products such as beets, rutabagas, and yellow turnips, these investigators obtained greater water absorption by soaking, but soaking was not considered helpful since the palatability of their products was judged highest for unsoaked vegetables and for those soaked for short periods, whereas it was lowest for those which were soaked for a longer period (2½ to 7 hours). Apparently, the inherent nature of individual products is an important factor in determining their response toward various treatments during reconstitution; therefore, the need for studying a large number of products is further indicated.

It is evident that the optimum amount of water required for reconstitution depends largely on the product. Too little water will be expected to slow down the rate of water absorption, due to the smaller surface area in contact with water, and it may also result in an inferior product and increase the probability of scorching at a later stage of reconstitution. However, large quantities of surplus water should be avoided because flavoring materials and valuable nutrients such as water-soluble vitamins and minerals may be lost to a large extent.

The temperature of water to be used for soaking and cooking is another problem for consideration. Higher temperature permits faster rate of water absorption and hence reduces total time required for reconstitution. On the other hand, whether or not the increase in rate will result in a larger amount of final water absorption and how the increase affects the palatability of various products are unanswered questions at the present time.

The chief purpose of this study has been to determine the amount and rate of water absorption during the reconstitution of certain dehydrated fruits and vegetables under different conditions. The variables included have been the ratio of water to dehydrated product and the initial temperature of the water. Although it has been reported that palatability increased with increase in water absorption during reconstitution only up to a certain stage, and that further absorption of water gave unfavorable effect, it should be realized that the products were not compared at similar stages of cooking *(3, 5)*. The lower score could well have been the result of overcooking or under-cooking. Therefore, a few limited tests have also been conducted in the present study to note the relationship between the percent of water absorption and the palatability of the reconstituted product where samples were compared at approximately the same doneness but with different amounts of final water absorption due to difference in treatment.

EXPERIMENTAL

Dehydrated products. The dehydrated products used included diced potatoes, flaked onions, French cut green beans, sweet corn and apple slices. The products were supplied by the Quartermaster Food and Container Institute for the Armed Forces, as samples of products currently in use by the Armed Forces.

Reconstitution methods. Most of the studies were conducted with small (usually 4-serving) portions, and when the studies with small portions were completed for a given product, a few of the experiments were repeated with large (50-100 serving) portions.

For small portion studies, 2-qt. aluminum saucepans were used for all except apple slices, and for these 1-qt. pans were used. Saucepans were uncovered throughout, and the products were not stirred during reconstitution. Temperature changes were recorded in the center of the product at 5-min. intervals in all cases, to insure consistent temperature changes as experi-

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ments were repeated. For some products, gas heat was used and heating was controlled by using a manometer attached to a gas line; for others, electric units were used and heating was controlled by using different speeds.

For large portion studies, an Army stock pot of 10-gallon capacity was used, with gas heat to provide heating capacity similar to that of an Army field range.

Standard methods of reconstitution. Preliminary work was done with each product to select a method of reconstitution which could be considered standard, on the basis of the color, texture, and flavor of the finished product, and on the practicability of the method. The chief interest in this work is in connection with large-quantity cookery of dehydrated fruits and vegetables for the Armed Forces. Hence, for each product, the time required for the large portion to reach boiling was first noted, then for the small portion the intensity of heat found necessary to bring it to a boil in the same length of time was used.

These selected methods are as follows:

Diced Potatoes: Seven times the weight of water as potato, initial temperature of water 24° C.; bring to boil in 30 min., simmer 13 min., and drain. For small portions, 115 g. per run; for large portions, 3118 g. per run.

Flaked Onions: Seven times the weight of water as onion, initial temperature of water 24° C.; bring to boil in 12 min., simmer 18 min., and drain. For small portions, 115 g. per run; for large portions, 805 g. per run.

French Cut Green Beans: Fifteen times the weight of water as green beans, initial temperature of water 24° C.; soak 15 min., bring to boil in 25 min., boil moderately 15 min. and drain. For small portions, 56.7 g. per run; for large portions, 852 g. per run.

Sweet Corn: Five times the weight of water as corn, initial temperature of water 60° C.; soak 25 min., bring to boil in 25 min. and simmer 20 min., then drain. For small portions, 185 g. per run; for large portions, 1818 g. per run.

Apple Slices: Seven times the weight of water as apple, initial temperature of water 60° C.; soak 15 min., bring to boil in 8 min., simmer 8 min. and drain. For small portions 50 g. per run; for large portions 1026 g. per run.

Variables studied. The two variables studied for each product were the initial temperature of the water and the ratio of water to product. Keeping the ratio of water to product constant, water with different initial temperatures was used. Keeping the initial temperature of the water constant, different ratios of water to product were used, and these ratios were kept within what were considered reasonable limits from a practical standpoint. For the smallest ratio of water for each product, an amount was chosen which seemed to cover the product fairly well and which seemed adequate to prevent scorching by the time the product was done. The largest ratio in each case was the amount which was considered the largest apt to be recommended from a practical standpoint.

Approximately the same intensity of heat was applied when reconstitution was started in hot water as when reconstitution was started in cold water. Hence, less time was required for the product to reach the boiling point when started in hot water, and a shorter total time was required for reconstituting the product to doneness. In all cases, information was obtained for the product at intervals during reconstitution, and when it was considered "done." In addition, information was obtained for an extended cooking time for the sample started in hot water to give a total reconstitution time the same as for the sample started in cold water.

Determination of percent water absorbed. For the standard method of reconstitution and for each variable the rate of water absorption was determined. This information was obtained in terms of the percent water absorption (grams water absorbed per 100 g. dehydrated product). The methods of determination for the various products follow.

Small Portions

Diced Potatoes, Flaked Onions and Sweet Corn. Of the total portion of the vegetable to be used for a run, given weights (10 or 15 g.) were placed in each of 3 or 4 "cages," depending upon the number of time-intervals for which determinations were required. The "cages" consisted of fine wire mesh which allowed free circulation of water but which did not permit solid pieces to pass through it.

Preliminary work with these "cages" was done to determine the value of this method. Determinations from repeated runs showed that the percent water absorbed by the product within the "cage" was very similar to the percent water absorbed by the product outside the "cage" at the same time-interval in the same cooking. Hence, the percent water absorbed as determined from the product within the "cages" was considered indicative of the percent water absorbed by the entire lot of product at a given time in a cooking.

The "cages" were removed from the pan at intervals during reconstitution, and were weighed after a uniform method of drainage. The percent water absorbed by the product remaining in the pan outside the "cages" was noted at the end of each experiment, and these results served as a check on the results from the "cage" to be removed last. In general, these results from the remaining portions agreed well with those from the "cage" to be removed last, but they are not presented here. At least three runs were included in all cases, from which to obtain an average.

For diced potatoes and sweet corn, the results were considered acceptable if the difference between the highest and lowest figures in a series did not exceed 10% of the average. For the most part, this agreement was readily obtained. Occasionally when this agreement was not obtained, another run was added and the results were then considered acceptable if the difference between the highest and lowest figures in a series did not exceed 15% of the average.

Greater difficulty was encountered in obtaining good agreement between results in a series using flaked onions, no doubt due to the widely differing thicknesses and sizes of the flakes. If the difference between the highest and lowest figures in a series did not exceed 15% of the average, the results were considered acceptable; otherwise, one run was added and then if the difference between the highest and lowest of the four figures did not exceed 20% of the average, the results were considered acceptable, and all four figures were used in computing the average. Finally, if the results were not yet acceptable, 2 more runs were added (a total of 6 runs) and all figures were used in computing the average unless any were extreme. In most cases, however, the difference between the highest and lowest of the original three figures was found to be within 15% of the average.

Apple Slices and French Cut Beans. The apple slices and the pieces of green beans were too large for use of the "cages" described above to be practicable. Hence it was necessary to stop reconstitution, drain and weigh the entire lot of the product at each time-interval for which information was required. An additional problem was encountered in reconstituting apple slices. The slices tended to float on the surface of the water and this made it impossible to obtain reproducible results. This was overcome by placing over the surface of the apples a fine, wire mesh, arranged so as to keep the slices continuously submerged during reconstitution. At each time-interval when reconstitution was stopped, the product was turned into a strainer and drained by a uniform procedure.

For both apple slices and French cut green beans, results were considered acceptable if the difference between the highest and lowest figures in a series did not exceed 10% of the average, and no difficulty was encountered in obtaining this agreement.

Large Portions

Diced Potatoes, Flaked Onions and Sweet Corn. Weighed portions of the product were placed in each of 9-12 "cages" as for small portion studies of these vegetables. At each time-interval, three "cages" were removed, drained and weighed as for small portion studies, and the three figures were used in computing the average. Results were considered acceptable if the difference between the highest and lowest figures in a series did not exceed 10% of the average for diced potatoes and sweet corn, and 15% of the average for flaked onions. Immediately after removing the last "cage," the remaining vegetable was drained into colanders for 10 minutes, and then weighed. These results from the remaining portions served as a check on the results from the "cages" to be removed last. The results from the remaining portions are not presented here, but in general

they agreed well with those from the "cages" to be removed last.

Apple Slices and French Cut Green Beans. Water absorption for these products was determined only when they were reconstituted to doneness. "Cages" were not used for apple slices, and when treatment was complete, the entire lot of apple was turned into colanders, drained 10 minutes, and weighed. For green beans, large "cages" each holding 25 g. were used. For both these products, the differences between the highest and lowest figures in every series was within 10% of the average.

Relationship between percent water absorption and palatability. For each product, a pair of samples reconstituted to approximately the same degree of doneness but treated differently (one treatment resulting in high water absorption and one in low) were rated by a taste panel for color, texture, and flavor. The pairs were selected on the basis of percent water absorption as previously determined. In this part of the study, a portion of each sample was used for redetermining the percent water absorption, and these determinations in all cases showed a difference between the paired samples in the same direction as the original determinations, thereby giving assurance that the products being compared represented high and low water absorption.

The taste panels included 27-33 judges, and they were given one pair at a time, to score from 1 to 9 for each quality, color, texture and flavor. The average score for each quality was used for comparing the products.

RESULTS AND DISCUSSION

Effect of variables on percent water absorption. *Effect of Ratio of Water to Product.* Results of studies with small portions are presented in Figure 1. A slight tendency is indicated in most cases for decrease in the ratio of water to product to result in decreased percent of water absorbed by the time the product is reconstituted to doneness. This effect is most pronounced with flaked onions when only 4 times the weight of water as onions were used, and it is noticeable also, when only 11 times the weight of water as green beans were used. In all probability, if smaller amounts of water had been used with other products, similar effects would have been found.

In general, the rate of water absorption was gradual for all products, regardless of the ratio of water to product. With all ratios of water to product, diced potatoes and apple slices showed a fairly steady rate of water absorption during reconstitution. With all ratios of water to product, sweet corn, green beans and flaked onions showed more rapid absorption during the early stages of reconstitution than during the later stages.

Effect of Initial Temperature of Water. Results of studies with small portions are presented in Figure 2. Each increase in temperature of water for diced potatoes, sweet corn and apple slices gave some increase in water absorption at each time interval during reconstitution. The effect of initial temperature was rather more pronounced during the early stages of reconstitution however, since there was a tendency for the percent water absorbed to "level off" to some extent toward the later stages. This means that the rate of water absorption is greatest in the early stages of reconstitution when the initial temperature of the water is high, and when the initial temperature of the water is low, water absorption is somewhat steadier throughout reconstitution.

The effect of initial temperature of water on water absorption by green beans and flaked onions was somewhat inconsistent during reconstitution, but by the time these products were reconstituted to doneness, increase in initial temperature of water decreased water absorption, an effect the reverse of that with all other products.

During the extended cooking period for samples started in hot water (giving the total reconstitution time equal to that for samples started in cold water)

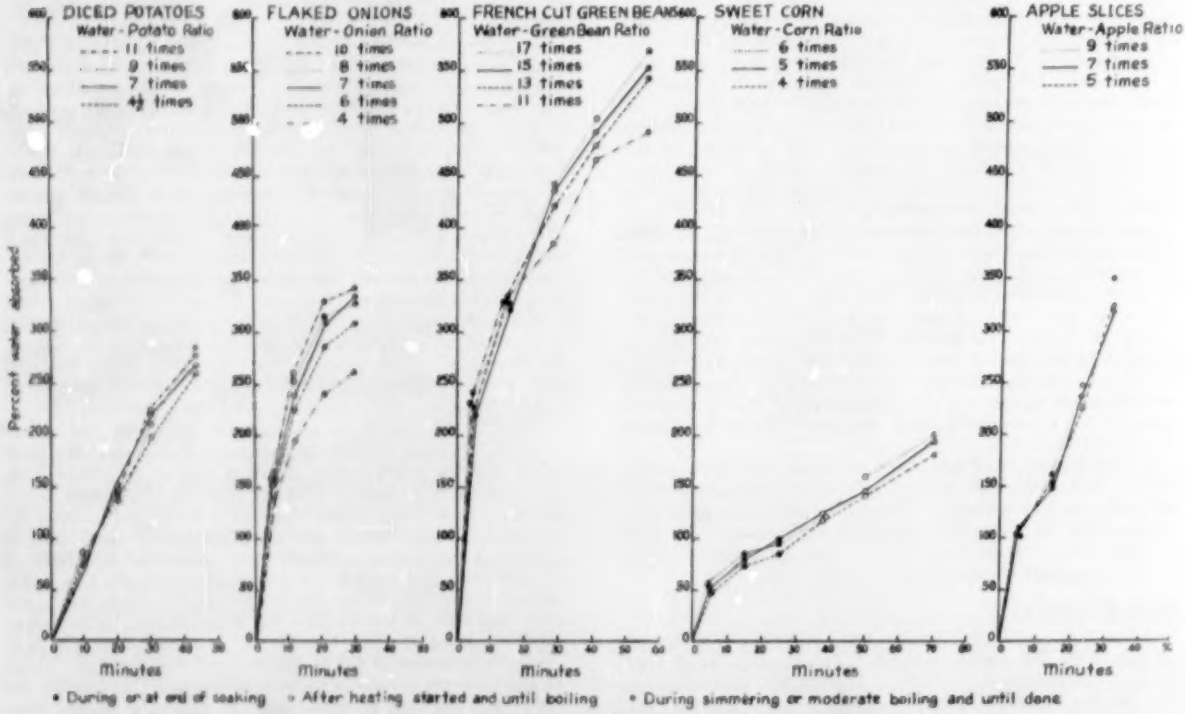

Figure 1. Effect of ratio of water to product on water absorption during reconstitution of dehydrated products.

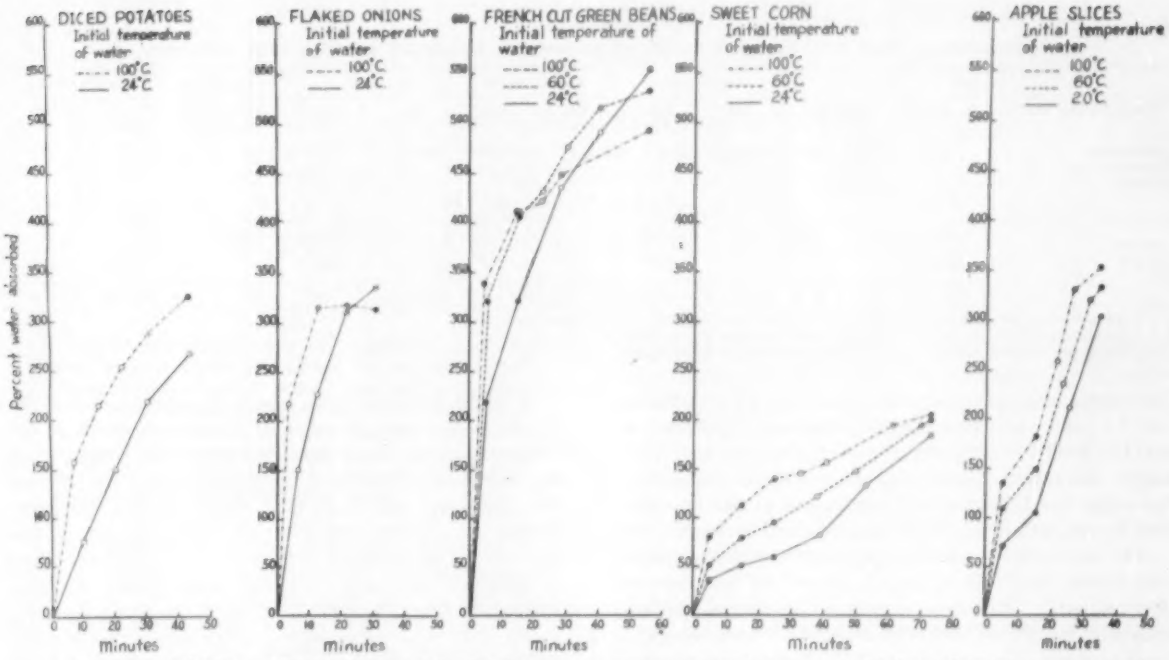

Figure 2. Effect of initial temperature of water on water absorption during reconstitution of dehydrated products.

water absorption increased at the rate similar to that for the period preceding, except for flaked onions and green beans. During this extended cooking period, increase in water absorption by green beans was very slight and there was no increase by flaked onions.

Large-Portion Studies. For comparison of results by large and small portions when reconstituted, bar graphs are presented in Figures 3 and 4. The general trends of effects due to ratio of water to product and due to initial temperature of water are similar for large and small portions. Data not included here also indicate that there was more rapid water absorption in the early stages of reconstitution by both large and small portions.

Results were analyzed statistically to determine whether the percent water absorbed by large portions was similar to that by small portions when the products were reconstituted to doneness. For each product in the study to determine the effect of ratio of water to product on water absorption, the average was obtained from all figures from all sets in the small-portion study, and this was compared with the average of corresponding figures in the large-portion study. These figures were analyzed statistically, using the *t*-test. Results from the study to determine the effect of initial temperature of water were similarly analyzed. For both studies, differences at the 1% level were found between small and large portions results for diced potatoes, sweet corn and apple slices. For diced potatoes and sweet corn, water absorption was greater by small portions, whereas for apple slices it was greater by large portions. No significant difference was found between small and large portion results from green beans or flaked onions.

Relationship between percent water absorption and palatability. Average scores for the products are presented in Table 1, with results of statistical analysis,

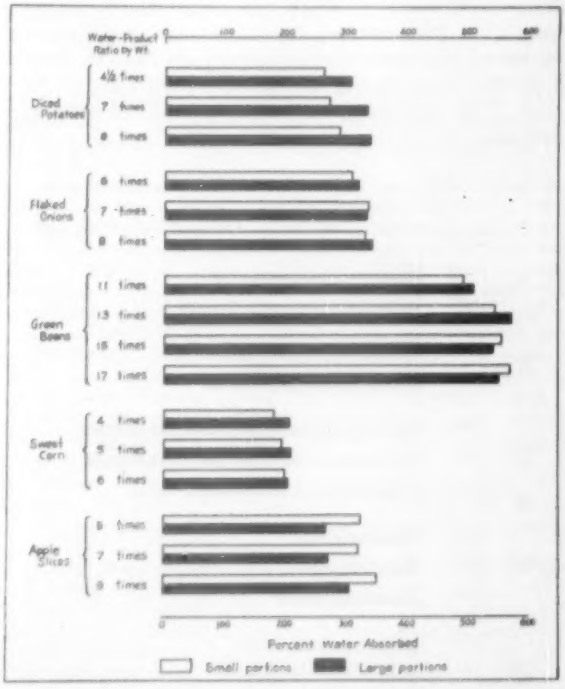

Figure 3. Comparison of effect of ratio of water to product on water absorption by small and large portions of dehydrated products when reconstituted.

using the *t*-test. In most cases, the difference between the scores of paired samples was only slight, and was not consistently in favor of low or high water absorption. However, for green beans (the pair with the greatest difference in water absorption) the sample with

TABLE 1

Comparison of taste panel ratings for products reconstituted to give low and high water absorption

Products		Diced Potatoes		Flaked Onions		Green Beans		Sweet Corn		Apple Slices	
Percent water absorbed, as originally determined		260	276	314	333	446	552	157	180	301	349
Abbreviated Reconstitution Method	Ratio of water to product, by wt.	4½	11	7	7	13	13	6	4	7	9
	Initial temperature of water, °C.	24	24	100	24	100	24	60	60	24	60
Average Score [1] for	Color	6.7	7.6[2]	6.7	7.1[2]	7.6	6.0[3]	6.9	6.5	6.2	6.1
	Texture	6.2	6.8[2]	6.8	6.5	6.7	6.4	6.9	6.7	6.7	6.7
	Flavor	6.6	7.0	6.5	6.5	6.9	5.9[3]	6.5	6.5	6.9	6.8

[1] All scores are averages of scores by 27-33 judges who rated each quality from 1 to 9.
[2] Significant difference between scores of paired samples at 5% level.
[3] Significant difference between scores of paired samples at 1% level.

low water absorption scored higher for all 3 qualities, and for color and flavor the difference was significant at the 1% level. For diced potatoes, the sample with high water absorption scored higher for all three qualities; for color the difference was significant at the 1% level and for texture it was significant at the 5% level.

The similarity in scores for most products is probably due to the fact that all samples were reconstituted to approximately the same degree of doneness, without extremes in method, and with no sample "water-logged."

SUMMARY

The percent water absorbed was determined during the reconstitution of diced potatoes, flaked onions, French cut green beans, sweet corn and apple slices, and the effects were noted of varying the ratio of water to product and varying the initial temperature of the water. The chief studies were with small (4-serving) portions.

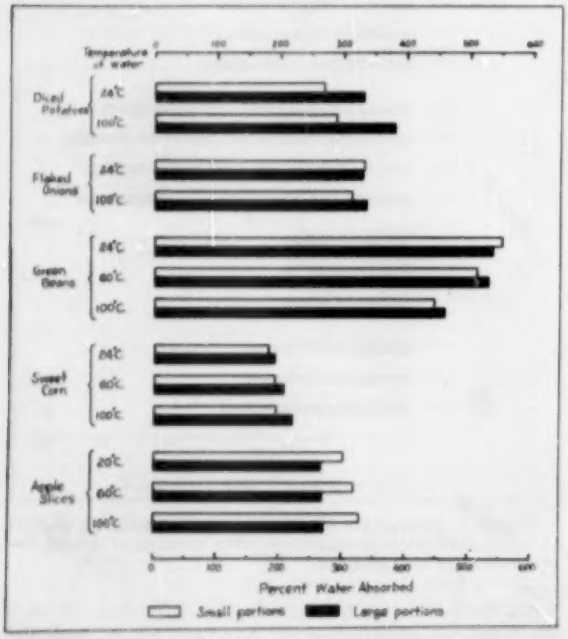

Figure 4. Comparison of effect of initial temperature of water on water absorption by small and large portions of dehydrated products when reconstituted.

A slight tendency was found in most cases for decrease in the ratio of water to product to result in decreased percent water absorbed when the product was reconstituted to doneness, particularly when the smallest ratio of water was used with flaked onions and green beans. In general, the rate of water absorption was gradual for all products, regardless of the ratio of water to product. Increase in initial temperature of water caused increase in water absorption by diced potatoes, sweet corn and apple slices, particularly in the early stages of reconstitution. On the other hand, when green beans and flaked onions were reconstituted to doneness, increase in initial temperature of water resulted in decreased water absorption.

When some of these experiments were repeated with large (50-100 serving) portions, the general trends of effects were similar to those with small portions. Products differed in their behavior as to whether the percent water absorbed was higher or lower with large portions than with small portions.

As judged by a taste panel, only slight differences in palatability were found between samples of reconstituted sweet corn, flaked onions and apple slices, when paired to compare the effect of high and low water absorption by each product. For green beans, the sample with low water absorption scored higher, but for diced potatoes the sample with high water absorption scored higher.

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Effect of Water Hardness in Reconstituting Dehydrated Fruits and Vegetables[a]

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Certain dehydrated fruits and vegetables were reconstituted in waters made hard by the addition of several concentrations of certain salts and in distilled water for comparison. Effect was noted on percent water absorbed and on taste panel ratings for texture of reconstituted products. Considerable difference was found as to the effects of the various salts and also as to the response by the various products.

The firming effect of hard water in canning has long been recognized as a problem by the canning industry. Huenink *(7)* in 1915, found both calcium and magnesium salts in the form of chlorides or sulphates had a firming effect on canned beans and the effect increased with calcium or magnesium concentration. As bicarbonate, the result was less consistent, probably due to the instability of bicarbonates. This effect was later confirmed by others in cooking dried legumes *(3)* as well as in cooking peas *(15)*.

It was also noted that vegetables such as green beans, asparagus, spinach, peas, parsnips, and squash were able to absorb calcium or magnesium ion from the cooking medium when cooked in water containing these salts. The calcium and magnesium contents of these vegetables after cooking were found to be higher than when they were raw or when they were cooked in distilled water or cooked by steaming *(9, 10, 11, 16)*.

The firming effect of calcium and magnesium salts on vegetables can probably be attributed to several different reactions. The fact that vegetables low in protein and rich in pectin become firmer is believed to be the result of the formation of insoluble calcium or magnesium pectate *(8)*. On the other hand, the firming of legumes which are rich in protein is mostly due to the formation of calcium and magnesium picrates or the precipitation of protein by the calcium and magnesium salts *(4)*.

Although firming effect is considered undesirable in cooking many vegetables, it has been found to be helpful in preserving the natural structure of certain types of fruits during processing. Kertesz *(8)* found that apples, peaches, strawberries and tomatoes treated with calcium and other alkaline earth elements were rendered firmer and had better structure after canning and freezing. Since then, the usefulness of calcium salts in canning and freezing has also been reported by many other workers *(1, 2, 5, 12, 14)*. The relative effectiveness of calcium citrate, malate and lactate in treating apple slices was compared by Holgate and Kertesz *(6)* and the results were comparable when used on an equal basis as to calcium content. There seems to be some indication of a slight superiority of lactate in both firming effect and calcium-uptake.

The purpose of this study has been to note the effect of reconstituting certain dehydrated fruits and vegetables in waters made hard by the addition of different concentrations of certain salts. Comparisons were made as to the effect on the rate and final amount of water absorption, and on the firmness of the reconstituted product.

MATERIALS AND METHODS

Dehydrated products. The dehydrated products used were diced potatoes, flaked onions, French cut green beans, sweet corn and apple slices. Samples from the same lots of products were used as those for the study in this laboratory, using tap water *(13)*.

Reconstitution methods. Each product was reconstituted by the method which was arbitrarily selected as the standard for experimental purposes in the previous study in this laboratory *(13)* in which products were reconstituted in tap water. Exception to this was diced potatoes, and the reconstitution method for this product in these studies included preliminary soaking.

Determination of effects of hard waters. Each product was reconstituted in a series of waters made hard by adding the 5 salts commonly found in hard waters; magnesium sulphate, magnesium chloride, calcium sulphate, calcium chloride and calcium bicarbonate. The hard-water solutions were prepared with distilled water and chemically pure materials. The concentrations arbitrarily selected were 125, 250, 500 p.p.m. (calculated as calcium carbonate equivalent) for each salt, and also 1000 p.p.m. of all salts except calcium bicarbonate. The products were also reconstituted in distilled water for comparison. In all cases, the average figure from 3 determinations was obtained.

To note the rate of water absorption, percent water absorption was determined at one or two intervals during reconstitution of each product.

Methods of rating reconstituted products. *Percent Water Absorbed.* The percent water absorption was determined by the same method as that used in the former study in this laboratory *(13)*.

Taste Panel Ratings. Reconstituted products were judged subjectively for firmness by taste panel ratings by at least 8 judges. The judges were always given a pair of samples at one time, one of which had been reconstituted in distilled water, the other reconstituted in hard water. Products were not seasoned and they were tasted hot. The judges were asked to indicate which sample they considered firmer, or whether they did not find any difference between them. Results of these ratings were analyzed statistically by chi square.

For each product, the effect of a concentration of 500 p.p.m. was first determined, and if an effect seemed evident, decreasing concentrations were used until no effect was found. If the concentration of 500 p.p.m. of a given salt had not resulted in a significant effect, the effect of a concentration of 1000 p.p.m. of that salt was also determined.

[a] Presented before the Fourteenth Annual Meeting of IFT, Los Angeles, California, June 29, 1954.

RESULTS AND DISCUSSION

Effect of hard waters on water absorption. Effect of different salts on the percent water absorbed when the 5 products are reconstituted to doneness is presented in Table 1. Data obtained for percent water absorbed at intervals during reconstitution indicated that when the final percent of water absorption in hard water differed from that in distilled water, the difference was generally in the same direction at each time-interval throughout reconstitution. Hence these data are not included here.

Differences (increases and decreases) in percent water absorption due to the presence of a salt were analyzed statistically, using the *t*-test. In general, calcium chloride and calcium sulphate decreased water absorption by all 5 products, in varying degrees for the different products. There seems to be a trend for increase in salt concentration to cause decrease in water absorption in most cases, but the trend is not consistent. Lack of consistency is probably due to experiment error and to lack of uniformity of the dehydrated product.

Effects of magnesuim salts were less pronounced and less consistent than effects of calcium salts. Both magnesium salts decreased significantly the percent water absorbed by diced potatoes and green beans. Magnesium sulphate consistently increased water absorption by apple slices, but the difference was significant only in one case, and this salt had very little effect on water absorption by flaked onions.

The effect of calcium bicarbonate was most inconsistent, probably due to the fact that this salt can readily be decomposed by heat during reconstitution.

No concentration of any salt had a significant effect on water absorption by sweet corn.

Effect of hard waters on texture as rated by taste panels. Taste panel ratings for texture of products reconstituted in hard waters are presented in Table

TABLE 1

Percent water absorption by products reconstituted in waters made hard by addition of certain salts

Addition to distilled water		Percent water absorbed by				
Kind of salt	Conc. in p.p.m. calculated as $CaCO_3$ equivalent	Diced Potatoes	Flaked Onions	Green Beans	Sweet Corn	Apple Slices
None		327	321	550	196	316
$MgCl_2$	125	304	326	529[1]	186	303
	250	299[1]	317	533[1]	189	311
	500	327	331	516[1]	197	310
	1000	307[1]	332	509[2]	184	299
$MgSO_4$	125	297[1]	324	549	190	338
	250	289[1]	323	529[1]	189	339[1]
	500	317	329	521	185	334
	1000	300	318	498[2]	184	323
$CaCl_2$	125	313	318	536	191	308
	250	277[2]	322	530	186	291
	500	307	322	508[2]	191	293
	1000	292[1]	305[1]	493[2]	183	261[1]
$CaSO_4$	125	301[1]	333	545	191	280[1]
	250	281[2]	323	547	194	288
	500	288[2]	320	540	183	290
	1000	293[1]	305[1]	500[2]	182	279[1]
$Ca(HCO_3)_2$	125	330	326	556	192	314
	250	319	336[1]	542	200	322
	500	312	318	520[2]	195	300

[1] Significant difference between distilled water and salt solution at 5% level.
[2] Significant difference between distilled water and salt solution at 1% level.

TABLE 2

Taste panel ratings for texture of products reconstituted in waters made hard by addition of certain salts

Addition to distilled water		Total no. of judges for					% of judges who rated hard water sample firmer for					Chi square value				
Kind of salt	Conc. in p.p.m. calculated as $CaCO_3$ equivalent	Diced Potatoes	Flaked Onions	Green Beans	Sweet Corn	Apple Slices	Diced Potatoes	Flaked Onions	Green Beans	Sweet Corn	Apple Slices	Diced Potatoes	Flaked Onions	Green Beans	Sweet Corn	Apple Slices
$MgCl_2$	125	10					45.0					0.100				
	250	10				8	50.0				43.8	0.000				0.125
	500	8	8	9	8	8	81.3	62.5	55.6	56.3	43.8	3.125	0.500	0.111	0.125	0.125
	1000	9	16	8	11	23	100.0	84.4	43.8	45.5	71.4	9.000[2]	7.563[2]	0.125	0.091	3.857[1]
$MgSO_4$	125	22				8	47.7				62.5	0.045				0.500
	250	22				13	38.6				42.3	1.136				0.308
	500	20	19	10	9	8	70.0	52.6	55.0	33.3	50.0	3.200	0.053	0.100	1.000	0.000
	1000	8	20	8	8	8	87.5	35.0	62.5	81.3	50.0	4.500[1]	1.800	0.500	3.125	0.000
$CaCl_2$	125	11					36.4					0.818				
	250	10	8			8	90.0	43.8			62.5	6.400[1]	0.125			0.500
	500	13	8	10	9	16	92.9	100.0	40.0	27.8	100.0	9.307[2]	8.000[2]	0.400	1.778	16.000[2]
	1000			8	9				75.0	33.3				2.000	0.000	
$CaSO_4$	125	12					37.5					0.750				
	250	18				8	63.9				68.8	1.389				1.125
	500	21	7	8	9	8	91.5	43.8	62.5	66.6	100.0	13.762[2]	0.144	0.500	1.000	8.000[2]
	1000		15	10	8			33.3	60.0	56.3			1.667	0.400	0.125	
$Ca(HCO_3)_2$	125	24				24	31.1				77.1	0.042				7.042[2]
	250	20	8			16	45.0	25.0			90.6	0.200	2.000			10.563[2]
	500	23	8	10	9	8	25.0	0.0	5.0	27.8	93.8	6.545[1]	8.000[2]	8.100[2]	1.778	6.125[1]

[1] Significant difference at 5% level.
[2] Significant difference at 1% level.

2, with statistical analysis by chi square. Some concentration of each salt except calcium bicarbonate resulted in significant or highly significant firming of potatoes, and some concentration of each salt except magnesium sulphate resulted in significant or highly significant firming of apple slices. Response of other products to different salts was less consistent, especially to calcium bicarbonate, which caused significant firming of apple slices but significant softening of diced potatoes, flaked onions, and green beans. This is the only instance in which any salt had a significant effect on the texture of green beans, and no salt had a significant effect on the texture of sweet corn. When a salt was found to have either a firming or a softening effect on a certain product, the effect, in general, became more pronounced with increased concentration of the salt as judged by taste panel ratings.

SUMMARY

Dehydrated diced potatoes, flaked onions, green beans, sweet corn and apple slices were reconstituted in a series of waters made hard by adding separately magnesium sulphate, magnesium chloride, calcium chloride, calcium sulphate and calcium bicarbonate to distilled water in several concentrations. Products were also reconstituted in distilled water for comparison.

Results are presented to show the effects of the different concentrations of each salt on the percent of water absorbed when the product is reconstituted to doneness. Calcium chloride and calcium sulphate caused in general a decrease in water absorption by all products, whereas the effects of magnesium salts were less pronounced and less consistent. The effect of calcium bicarbonate was least consistent of all the salts.

Taste panel ratings of the products reconstituted in these solutions indicated that some concentration of most salts caused firming of diced potatoes and apple slices. Response of other products to different salts was less consistent, and the effects of calcium bicarbonate on texture was most inconsistent of all the salts.

None of these solutions had a significant effect on sweet corn as to either percent water absorption or the texture of the reconstituted product.

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An Evaluation of Radiation Sources as a Means for Processing Foods[a]

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A new method for the preservation of foods is under experimental development as a result of man's increasing ability to control particles of smaller than atomic size. It is gratifying that attention is being given in ever greater degree to methods of using these bits of matter and/or energy for other than the production of destructive weapons. The application of this source of energy to foods may prove to be of far-reaching importance. If successful, the extent of changes to come in food processing and packaging will be limited only by the imagination and the capabilities of scientists and technologists.

The phase of radiation study to be discussed in this article is sources of radiation—their merits and limitations. Sources currently used by the Army's Radiation Sterilization Project and sources proposed for use will be described.

[a] Presented at the Annual Meeting of IFT in Columbus, Ohio, on 15 June 1955.

Not all forms of ionizing radiation can be used to preserve foods. For example, *alpha* rays cannot be used because of the scarcity of such sources and the extremely short range of alpha particles in any medium. Protons, deuterons, and other large charged particles are not usable for the same reason. While it is true that the impact of positively charged ions upon matter will liberate recoil electrons, i.e., delta rays, these have an energy in the range of only a few kilovolts and limited penetrative power; hence, they, too, may be disregarded. Also, with these highly energetic positive ions one encounters the possibility of induced activity.

Neutrons in sufficiently high flux for preserving foods will be found only in reactors. Here one runs into a strong probability of induced activity and the transmutation of elements both in food and in food containers.

It is generally agreed that the biggest obstacle to be overcome, prior to the production of an acceptable irradiated product, is flavor change. Flavor changes appear to be due to the rupture of intramolecular bonds or to polymerization caused by irradiation. In the case of neutrons there is the added possibility of transmutation and further changes in the molecular structure itself. For example, P^{31}, the only isotope present in naturally occurring phosphorus, captures a neutron to become a P^{32}, which in turn decays to S^{32} with the emission of a 1.7 Mev beta particle with a half life of 14.3 days. Thus, to the problem of chemical bond rupture, which must be faced with any form of radiation, is added the introduction of new elements in foodstuffs. This means the increased possibility of the formation of undesirable compounds.

ELECTRONS AND GAMMA RAYS COMPARED

This leaves us with electrons and gamma rays as possible types of radiation for foodstuffs. Gamma rays have great penetrating power compared to electrons. For example, in water, the half thickness (i.e., the thickness required to reduce the intensity of a beam to a half its initial intensity) is about 4 inches for the 1.1 and 1.3 Mev gammas of Cobal 60, or slightly more than 3 inches for the 0.67 Mev gammas of Cs^{137}. Compare this with a maximum range of about 1/6 inch for 1 Mev electrons and 3/8 inch for electrons having 2 Mev of energy. Using a double pass technique, one can say that the maximum *effective* penetration for electrons is about 1/4 inch per Mev. Thus, insofar as penetration is concerned, gamma sources are much superior to electrons. On the other hand, insofar as dose rate is concerned, the preference goes to electrons. The most intense gamma sources used to date are spent fuel rods from the Materials Testing Reactor at Arco, Idaho; here we have attained dose rates as high as 10 megarep/hour. (1 megarep = 1 million rep). However, electron accelerators operate at 35 megarep/minute as an average value.

Other points to be considered when comparing these two types of radiation are the added shielding needed for gamma sources as compared to electron machines, the fact that gamma sources cannot be shut off, while an electron machine can, the fact that an electron source is mechanical with its attendant headaches, and the fact that a gamma source's activity decays exponentially. Depending on the particular operation for which an irradiation facility is designed, these may be either advantages or disadvantages.

I would like to describe briefly the various gamma sources that are now available or are proposed for the Radiation Sterilization Project. At present the most active source is at the Material Testing Reactor (Figure 1) which is located at the National Reactor Testing Station in Idaho. Periodically spent fuel rods are removed from the pile (or reactor) into a canal containing 18 feet of water. The fuel rods are hot thermally and radioactively, and the water in the vicinity of the rods gives off an eerie bluish light, called the Cerenkov glow. These rods are placed in a rack or grid in such a manner that sealed containers of food can be lowered into the canal near the rods and exposed to an intense gamma flux. There is one limitation—the difficulty in controlling the temperature of the samples during irradiation. Also, should the inert metal casing or cladding in which the fissionable material is sealed be ruptured, some of the soluble fission products will contaminate the canal water and be deposited on the food containers themselves. This requires scrubbing each can until the active contamination is removed. There have been instances where the precipitated activity could not be removed entirely, and the cans had to be buried. However, in no instance has there been a case of measurable induced activity. With the construction of a new installation, which permits No. 2 cans to be sealed in insulated metal cylinders and lowered into the canal to predesignated locations, all possibility of contamination has been removed. This arrangement, moreover, allows better temperature control, since the cans are removed from direct contact with the water, which is maintained at 78° F.

In April, 1955, a new gamma source became available at the Dugway Proving Ground, Utah, when the Army was licensed to use 8 spent fuel rods from the Materials Testing Reactor (Figure 2). These rods are being utilized pending the time when the more active fission

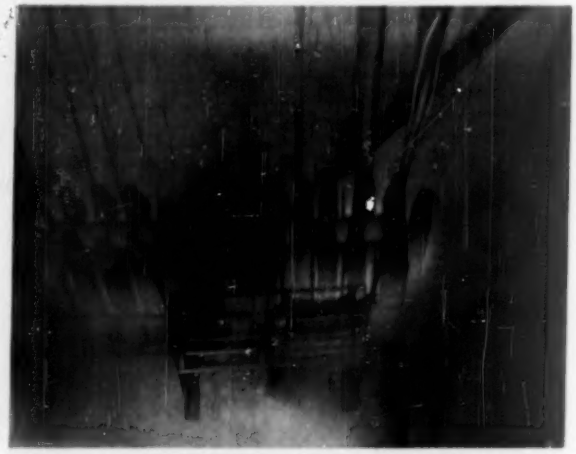

Figure 1. View looking down into water-filled canal of the Materials Testing Reactor at the National Reactor Testing Station. Cylinder holding can of food being irradiated is on rotating rig in front of gamma-emitting used reactor fuel elements.

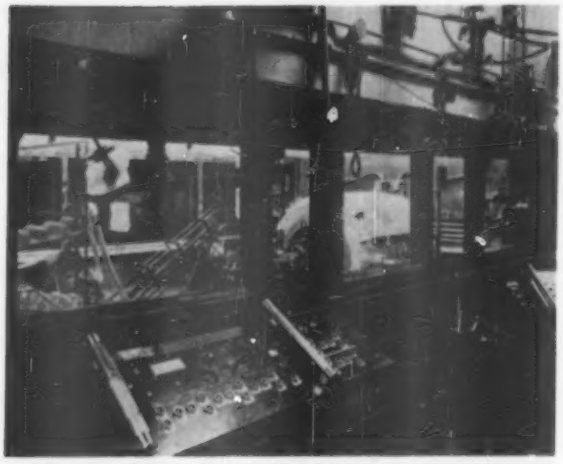

Figure 2. Radiation facility at Dugway Proving Ground, Utah. The eight MTR fuel rods are contained within the 25,000-pound lead and steel "pot," which can be observed through the thick windows which surround the facility.

products decay to a level of activity that will permit the rods to be sent to a chemical processing plant for the recovery of whatever fissionable material still remains. During the time the rods are used by the Army, they are arranged in a cylindrical shape so that food in Number 2 or Number 10 cans can be passed along the axis of the cylinder to receive a maximum dose rate of about 2 megarep/hour. The rate at which the cans move through the facility can be regulated to achieve the dose desired. The source can handle a maximum of about four No. 10 cans or six No. 2 cans an hour for a sterilizing dose of 2 megarep. In order to make the dose distribution as even as possible the facility is designed so that the cans are rotated continually at a slow rate. It is hoped that eventually temperature can be controlled to within 2° F. by passing fluids through coils in the 13-ton lead and steel shield that encompasses the irradiation volume. About two tons of food per month can be processed at Dugway.

Fission products give off a spectrum of gamma radiation. This is of no particular concern except when the rods are still fresh from the pile. At such a time there is a possibility that a small flux of photoneutrons will be produced due to the action of the more vigorous gamma photons on the deuterium, or heavy hydrogen. This constitutes about 0.0156% of naturally occurring hydrogen. This requires gamma photons of greater than 2.3 Mev energy, and such energetic emanations are obtained only from the short lived fission products. Hence, one is restricted to a degree in obtaining fuel rods from a reactor without a short "ageing" period.

At present there is under construction a smaller facility at Dugway to be activated by five plates of cobalt that have been irradiated in the reactor at Brookhaven. These plates, which are about 14 x 2⅛ x ⅛ inch, are encased in aluminum. Each plate has an estimated activity of between 600 and 700 curies. When placed in a pentagonal arrangement to permit the passage of No. 2 cans, they will deliver a dose rate estimated at ½ million rep per hour. This source is to be used as a laboratory tool rather than as a production facility in order to permit comparison of the effects of a spectrum of gammas, such as can be obtained from fuel rods, with gammas of a definite energy, such as can be obtained from cobalt. The production rate of this facility will be only about ⅜ pounds of food an hour.

A third fuel element facility, established at Argonne National Laboratory, consists of eight rods placed vertically in a grid at the bottom of a water tank 18 feet deep. Number 2 cans will be sealed in metal containers and lowered into predesignated slots in the grid so that total dosage may be controlled. To keep the radiation level high, four rods a month will be replaced by fresher elements from the Materials Testing Reactor. In an eight-hour day this facility should be able to deliver a 2 million rep dose to about 70 No. 2 cans.

There are a number of other cobalt sources in use part time by participants in the Radiation Sterilization Project. The largest is located on the University of Michigan campus. It consists of a cylinder whose sides are made of 100 cobalt rods a quarter of an inch in diameter and 10 inches long. This source will give doses in the range of ¼ megarep per hour inside the cylinder formed by the rods. The inside diameter is about 8 inches.

Figure 3. The 4200 curie cobalt source located at Stanford Research Institute. Note the three pieces of cobalt at the bottom of a pool 10 feet deep and located in front of the aluminum window which separates the pool from the subterranean irradiation room.

The Stanford Research Institute source (Figure 3), about 4200 curies of cobalt, is in a "swimming pool," 10 feet deep. Small vials or sealed test tubes can be given a dose rate as high as 800,000 rep/hour by placing them inside the pipe-shaped cobalt sources; larger objects can be given dose rates of up to ¼ million rep/hour by placing them in a small subterranean room, separated from the pool by a ⅝ inch aluminum window. The dose rate can be varied by changing the distance between the source and the window. Other small cobalt sources which have been used in dosimeter development studies are located at the Massachusetts Institute of Technology, Columbia University, and the Naval Research Laboratory in Washington.

The cobalt source at Brookhaven has been used in the work on inhibiting the sprouting of tubers, not a part of the Army's project. Much of this work parallels the work done by the group at Michigan.

ELECTRON ACCELERATING MACHINES

At present four different types of electron accelerating machines are being used: the resonant transformer of General Electric, the Van de Graaff accelerator of the High Voltage Engineering Corporation, the linear accelerator of Applied Radiation Corporation, and the capacitron of the Electronized Chemicals Corporation. A linear accelerator is also near completion at the High Voltage Engineering Corporation. General Electric is also experimenting in this field.

The resonant transformer (Figure 4) produced by General Electric's X-ray Division in Milwaukee was originally designed as an X-ray unit. However, by removing the heavy metal target and permitting the electrons, accelerated to 1 Mev, to be directed at items on an endless belt, we have a source of machine-made radiation which can produce a dose rate of up to 35 megarep per minute. The energy of the electrons may be controlled over a range of ½ to 1 Mev with a current of ¼ to ½ microamp. It would thus be possible for this machine to deliver a dose of 2 megarep to 50 to 70 pounds of food per hour under good operating conditions. This assumes that about half of the energy of electron machines is absorbed in the food.

At a symposium held in Milwaukee, 21, 22 March, 1955, it was announced that manufacture of three new models of the resonant transformer had begun. The power outputs planned indicate that these machines will be capable of handling, theoretically, up to 2,000 pounds of food per hour. These accelerators are being designed to produce 1, 2 and 4 Mev electrons at power ratings of 4, 10 and 17 kilowatts, respectively. They are also equipped with necessary oscillating magnetic fields to permit the beam to sweep back and forth across the object being irradiated, thus allowing for more even distribution of dose.

The Van de Graaff generator is manufactured by the High Voltage Engineering Corporation in Cambridge, Massachusetts. This machine operates on the principle of an electrostatic machine in that a charge is sprayed on an endless belt and then drawn off to the surface of an insulated sphere and eventually discharged along an accelerating tube. Various sizes of this instrument have been made to produce electrons of 1, 2, 3 and 6 Mev. At its Cambridge, Massachusetts, plant the High Voltage Corporation has established an irradiation facility that might well serve as a model for future installations. An endless belt arrangement for passing items to be irradiated under the beam permits continual operation. The beam oscillates in a plane perpendicular to the path of the food at a rate of 200 cps to increase uniformity of dose. Concrete baffle walls prevent the escape of any beam from the 2 Mev facility, thus protecting personnel completely. This particular machine is rated at 2 Mev and develops ½ KW of power, or sufficient power to sterilize up to 140 pounds of product per hour.

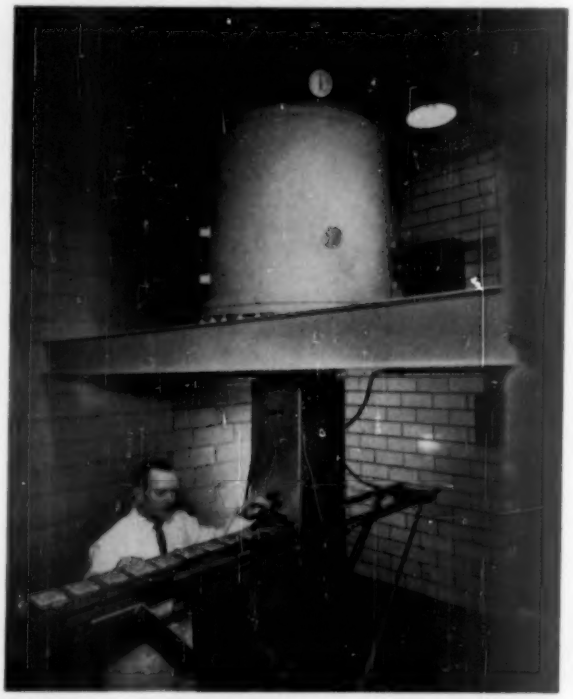

Figure 4. Mev General Electric Resonant Transformer showing pressure tank and enclosed accelerating column.

The capacitron operates on the principle of charging a number of condensers placed in parallel. When the condensers are suddenly switched to a series circuit, there is a tremendous flow of electrons of 2 Mev energy, lasting only a few microseconds. Each burst delivers a dose that can vary from 5,000 to 400,000 rep. At present there is but one experimental model of this machine. It has been in operation for some eight years in Brooklyn, New York. A new model of more practical design is now being built in St. Louis by the Electronized Chemicals Corporation and the Maloney Electric Company. It has been claimed that this very high dose rate permits the sterilization of foods without causing the undesirable flavor, color and odor changes that occur at slower rates. However, this statement is open to question by many investigators. Further research on rapid, massive doses is being conducted at the Quartermaster Food and Container Institute as well as at other laboratories.

Although the first model was built in the United States by D. H. Sloan and E. O. Lawrence in 1931, the linear accelerator is an instrument whose development until recently had been more vigorously pursued in Great Britain and other countries overseas than in the United States. Commercial models are now being designed by at least three firms in this country. This machine operates on the principle of increasing the energy of electrons as they pass down a tube of coaxial cylindrical electrodes (or drift tubes) of increasing length. The energy is applied to the electrons through the electrodes by means of a rapidly oscillating electrical field whose frequency is in the range of that of radar units. Theoretically there are no limitations to the energy level to which these electrons can be raised except that imposed by the amount of "real estate" required for the length of tube desired. Roughly, one can say that the energy increases 1 Mev per linear foot of tube.

At present the Radiation Sterilization Project is utilizing the accelerator developed by the Applied Radiations Corporation of Walnut Creek, California. This machine produces 4 KW of electrons at 6 Mev, which, under favorable conditions, would indicate a possible output of over 800 pounds of sterilized food, in one to one and a half inch layers, per hour.

Since there is no evident limit to the energy to which electrons can be accelerated, there comes to mind the problem of possible nuclear reactions which might be induced by an electron of sufficient energy to penetrate the nucleus itself and cause the ejection of one or more nucleons. This question of electrodisintegration is one which has not been investigated very extensively. Only a small amount of scientific literature has been devoted to this phenomenon. In order to help fill this gap in our knowledge, Dr. Lester Skaggs of the Argonne Cancer Research Hospital at the University of Chicago has undertaken a research project to measure threshold energies and cross-sections for interaction of electrons of greater than 10 Mev with nuclei of isotopes of elements found in foods. His radiation source is a 50 Mev linear accelerator built by High Voltage Engineering Corporation, who also are now building a commercial model machine in the 6 to 10 Mev range. The 50 Mev machine was designed primarily for cancer therapy and has a low power output, but its flexibility in energy ranges makes it an excellent tool for the research project.

FUTURE DEVELOPMENTS

The possibility of utilizing a reactor as a gamma source has been considered. The principal drawback here is the fact that only about 1% of the energy of fission is available for this process. Over 80% of the energy released is in the form of kinetic energy of the fission fragments themselves, and this is converted into heat. The possibility of a food processing plant run by power from the reactor has been suggested. It would also supply the necessary active fission products to operate the gamma facility. Several different methods have been proposed for extracting the gamma energy from a reactor:

a. A swimming pool type of reactor might be utilized, where the fissionable materials in the form of rods are immersed in a pool of water, and the items to be irradiated moved to the vicinity of the core of the reactor and exposed to the gammas of the fission process itself. It is expected that the water would reduce the neutron flux to a tolerable level. However, the gamma flux would also be reduced by the water, and the irradiation delivered might prove to be of doubtful intensity.

b. A heterogeneous reactor might be designed to permit the use of a coolant which, as it passes through the reactor, becomes radioactive with a short half life. Such a plan utilizing a liquid sodium or Na-K amalgam as coolant has been designed by the North American Aviation Company, and a reactor utilizing this principle will be built in the Los Angeles area.

c. In a heterogeneous reactor which is water cooled we might dissolve a salt, one of whose ions has a high cross-section for neutron activation to form a gamma emitter with a short half life. Manganous salts, such as $MnSO_4$, offer a possibility in this regard.

d. A homogeneous reactor, which has its fissionable material in solution might be designed so that the fuel solution could be circulated through pipes in a volume to be used as the irradiation facility. Neutron shielding must be considered here, since about 0.2% of all neutrons liberated as a result of fission are delayed neutrons with an emission half life of over 20 seconds. Such a design is being incorporated in the reactor being built by the Gamma Corporation in Mansfield, Massachusetts.

e. There is a possibility that in a homogeneous reactor some of the circulating fluid might be tapped off at intervals to permit chemical extraction of active fission products. This procedure would probably be required several times a day to obtain the greatest amount of activity.

f. A water boiler reactor might be designed so that the gaseous fission products could be piped off and pumped through coils or plates in the irradiation area. About one-third of the active fission products, ten seconds after fission, are in gaseous form; namely, as xenon, krypton, and iodine vapor. Since the active isotopes have half lives in the 7 to 17 seconds range, these gases must be removed rapidly from the reactor core if they are to be of use. This idea is being incorporated in the reactor being built at the Armour Research Foundation of the Illinois Institute of Technology in Chicago.

g. Another possibility is to utilize the N^{16} which is produced by the (n, p) reaction of neutrons in the reactor with the O^{16} present in the water coolant. N^{16} has a half life of about 7½ seconds and emits a beta particle accompanied by very penetrating gamma rays as it decays back to O^{16}. Such a source would require a rapid removal of the nitrogen gas to the radiation facility and a method of recombining safely the free hydrogen and oxygen into water again. This particular problem of recombination has apparently been solved by reactor designers.

Other gamma sources may become available if the active fission products of reactors can be isolated or concentrated into the forms desired. A chemical separa-

tion plant is now being built at Oak Ridge and should be able to deliver some sources of desired characteristics within two years. In addition, there is always the possibility that some day, when our stockpile of atomic weapons has been supplied with sufficient quantities of fissionable isotopes of the transuranic elements, a few of the production reactors of AEC might be used to produce almost limitless amounts of cobalt 60 for sources. A project to produce megacurie amounts of cobalt 60 in production reactors has been suggested.

It cannot be said at this stage of development that any given source—either machine produced electrons or nuclear products gammas—is the most desirable for a particular product. Such information can come only with experience and with further development of what is still an art, not a science. It may be, however, that one day the food technologist and the physicist, aided by other scientists and technicians, will develop a new "fireless cooker" based on the controlled and "peaceful" power of the atom.

A Preliminary Study of the Effect of Gamma Radiation on the Baking Quality of Flours[a,b]

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Infestation by insects of stored grain, flour, cereal meals, and other cereal products results in a great annual loss of these staple food items. Studies have indicated that a gamma radiation dose of 25,000 rep is sufficient to control such insect infestation in cereal products *(5, 6)*. However, little information has been published on the effects of gamma radiation on the quality of cereal products. To explore this question a preliminary study has been made of the quality of bread, biscuits, and cake prepared from irradiated bread and all purpose flour.

The first commercial facilities for gamma irradiation of food will probably, for reasons of economy, use cooling reactor fuel elements or the separated fission products as sources of radiation. Although large quantities of gamma emitters are present in the waste fission products, they exist in the form of dilute liquids and slurries stored in underground tanks for processing at some future date.

In June of 1951, Michigan, and later other universities, received "kilocurie" cobalt-60 gamma sources from Brookhaven National Laboratory *(2, 7)*. These gamma sources, which serve as substitutes for the fission products, are quite expensive because they are made by neutron bombardment in a reactor. However, they are useful laboratory tools and, as such, are more convenient and probably as cheap as waste fission products processed on a small scale. More important, these kilocurie sources are available now, but processed gross fission products are not.

A larger cobalt-60 source, ten times as powerful and of different design, has been installed in the Fission Products Laboratory *(3, 8)* and has greatly increased the range of possible experiments. For example, with the new source it is possible to sterilize whole hams and number 10-sized tin containers, and to irradiate sufficient volumes of food to conduct appropriate animal feeding experiments. The essential features of the radiation cave are four-foot thick concrete walls, necessary to shield laboratory personnel and the surrounding area from gamma radiation, and a 16-foot well used for shutting off the radiation in the cave. A four-foot barrier wall provides a simple labyrinthine entrance and prevents the source from "seeing" the door. The barrier wall serves to diminish the radiation flux in the labyrinthine entrance so that a heavily shielded door is not required. The door is provided with a safety interlock so that it is impossible to enter the radiation cave when the source is in the raised position.

Figure 1 shows the source in the well of water. This photograph was taken by the light from the glow caused by the effect of gamma radiation on the water in the well.

EXPERIMENTAL METHODS

A. Cakes

In the first test with irradiated flour three types of flour: (1) bread flour, (2) all-purpose flour (General Mills), and (3) cake flour (Swansdown), were given 20,000 rep of gamma radiation. Baking tests were made the day following irradiation. A quick-mix cake flour recipe was used to make cakes with the irradiated and nonirradiated cake flour, whereas a quick-mix all-purpose flour recipe was used for the irradiated and nonirradiated all-purpose and bread flour. Table 1 gives the formulas and method used.

One cake was baked with each flour, nonirradiated and irradiated, and used for two taste panels. The data were not analyzed statistically since there were too many variables. However, the general conclusion made was that a low dose of gamma radiation (20,000 rep) does not affect the baking, eating qualities, and flavor of the three flours. The volumes of the cakes made with the irradiated flours were equal to those made with nonirradiated flours. The cakes made with irradiated and nonirradiated bread flour were extremely heavy and soggy with poor symmetry and volume.

A second test with irradiated flour was made to explore whether or not the gluten of bread flour could be modified by radiation in such a way as to make a softer crumb. A quick-

[a] Work performed under U. S. Atomic Energy Commission Contract No. AT (11-1)-162.

[b] Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 15, 1955.

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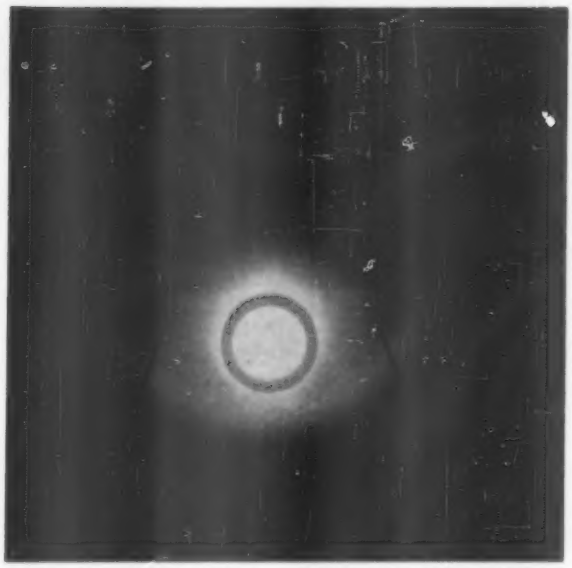

Figure 1. Photograph of multikilocurie cobalt-60 gamma source glowing under ten feet of water.

mix recipe for making cake with bread flour was first developed. Then cakes were made with irradiated bread flour that had been exposed to gamma radiation doses of 20,000, 50,000, 100,000 and 150,000 rep. Table 2 gives the formulas and method used.

All the cakes browned evenly and had a golden brown crust. The cakes made with flour given 50,000, 100,000, and 150,000 rep were more flat topped (not as symmetrical) than the control and the cake made with 20,000 rep. There was no noticeable difference between the control cake and that made with 20,000 rep bread flour. The cakes made with 50,000 and 100,000 rep bread flour were considered to be of better quality than that made with 150,000 rep flour, which had a wet soggy layer near the bottom of the cake. These results are shown in Table 3 (using rank analysis of incomplete blocks) *(1, 4)*.

Using a radiation dose of 50,000 rep some flavor change was observed, but cakes made from flour given 100,000 and 150,000 rep were considered to have a different flavor. It is difficult to describe this flavor change other than to say that the sweetness appeared to have been increased. These tests indicated that irradiating bread flour did not improve its qualities with regard to use in cakes.

In a third test more bread flour was exposed to doses of 100,000, 150,000, 200,000, 500,000, and 1,000,000 rep. Cakes were made with all the irradiated flours and a nonirradiated control. For the taste panel tests cakes made with flours exposed to 150,000, 200,000, and 500,000 rep were used. Figure 2 shows the 6 cakes made with irradiated and nonirradiated bread flour. Table 4 gives the cake characteristics; Figure 3 shows the effect of dosage upon cake height.

TABLE 1

Quick-mix cake formula developed for use with cake flour and all-purpose flour

Quick-Mix Cake Flour Recipe		Quick-Mix All-Purpose Flour Recipe	
Ingredients		Ingredients	
Flour	2¼ c	Flour	2 c
Sugar	1½ c	Sugar	1¼ c
Salt	1 tsp	Salt	1 tsp
Baking powder	3 tsp	Baking powder	3 tsp
Shortening	½ c	Shortening	½ c
Milk	⅞ c	Milk	1 c
Eggs	2	Eggs	2
Vanilla	1 tsp	Vanilla	1 tsp

Method: Sift together flour, sugar, salt, and baking powder. Place in mixing bowl with the shortening and approximately three-fourths of the milk. Beat for 2 minutes (150 strokes per minute). Scrape bowl often. Add eggs, vanilla, and remaining milk. Beat for 2 more minutes, scraping bowl often. Divide batter into two 8-inch layer pans. Bake at 350° F. for 30 to 35 minutes. Let cool on racks for 10 minutes before removing from pans.

TABLE 2

Quick-mix cake formula developed for use with bread flour

Ingredients	
Flour	2 c
Sugar	1½ c
Baking powder	3½ tsp
Salt	1 tsp
Shortening	½ c
Milk	1 c
Eggs	2
Vanilla	1 tsp

Method: Sift together flour, sugar, salt, and baking powder. Place in mixing bowl with the shortening and approximately three-fourths of the milk. Beat for 2 minutes (150 strokes per minute). Scrape bowl often. Add eggs, vanilla, and remaining milk. Beat for 2 more minutes, scraping bowl often. Divide batter into two 8-inch layer pans. Bake at 350° F. for 30 to 35 minutes. Let cool on racks for 10 minutes before removing from pans.

TABLE 3

Ranking, by taste panel, of cakes prepared from bread flour

Test	Megarep dose	0	0.05	0.10	0.15	0.20	0.50	P	Sign. Dif.?
1A	Score	26	26	28	28			.91	No
2A	Score	21	30	29	28			.04	Yes
	Preference	.62	.10	.12	.15				
1B	Score	18			23	22	27	.04	Yes
	Preference	.56			.17	.21	.06		
2B	Score	19			22	21	28	.02	Yes
	Preference	.45			.22	.28	.05		

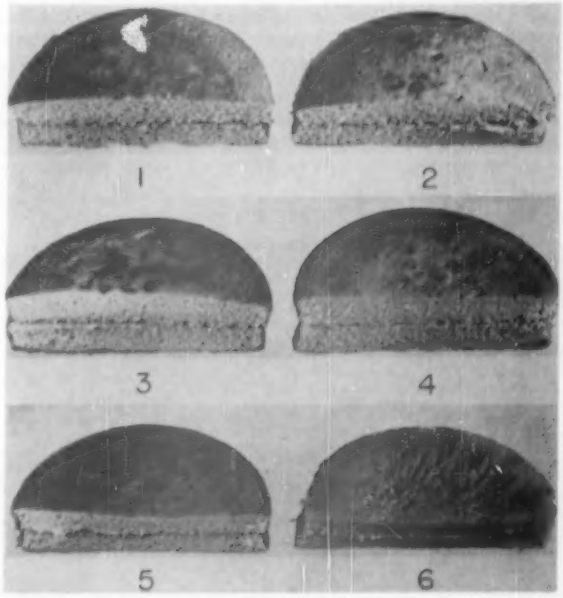

Figure 2. Cakes made with irradiated bread flour; control, 100,000, 150,000, 200,000, 500,000, 1,000,000 rep, respectively.

It was noticed that when mixing cakes with flour given 500,000 and 1,000,000 rep the batters tended to be drier and had a consistency like putty during the first 2 minutes of mixing. Taste panel results are shown in Table 3. The judges showed a slight preference for the control over the cakes made with flour given 150,000 and 200,000 rep. However, there was a decided preference for the control cake when paired with cake made with flour given 500,000 rep. Cakes made with irradiated flour tend to be sweeter, particularly the crust. Flour given 5.10^4 and 10^6 rep had an odor resembling extreme mustiness.

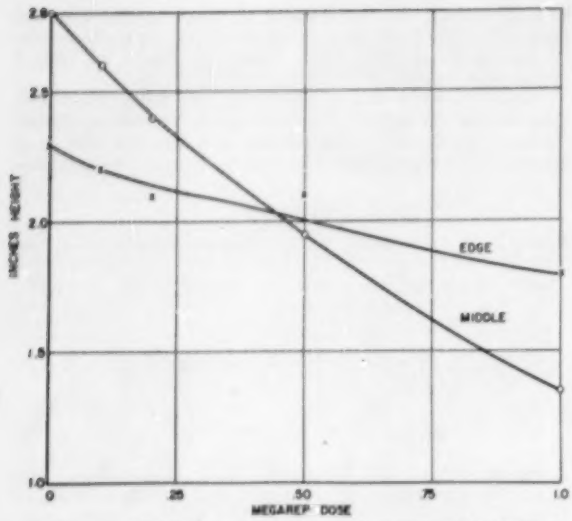

Figure 3. Height of cakes, edge and center, made from irradiated bread flour as a function of irradiation dose.

B. Baking Powder Biscuits

Baking powder biscuits were baked with bread flour that had been exposed to 20,000, 50,000, 100,000, and 150,000 rep of gamma radiation. Table 5 gives the formula and method used. It was decided to bake biscuits because color changes, if any, in irradiated flour would show up better in biscuits. Two bakings were made with each sample of treated flour and the nonirradiated control. Two taste panels were held with these biscuits; results are showwn in Table 6. Table 7 gives the biscuit characteristics.

The control biscuits were observed to have the greatest volume. There was no apparent difference in volume in the biscuits made with irradiated flour. All the biscuits browned an equal amount and there were no differences in outer appearances.

TABLE 4

Characteristics of cakes made with irradiated bread flour

Dose, rep	
0	Best symmetry, volume, texture, crumb color and tenderness.
100,000	Good cake, slightly coarse and compact, less tender.
150,000	Heavy compact layer near bottom, darker.
200,000	Bready, coarse, wet, sticky, flat top.
500,000	Dip in center, heavy, compact, bready, coarse, tough, gummy.
1,000,000	Fell badly, dark, wet, soggy.

TABLE 5

Formula developed for use in making biscuits with irradiated bread flour

Ingredients			
Flour	2 c	Shortening	¼ c
Baking powder	3 tsp	Milk	180-190 cc
Salt	½ tsp		

Method. Sift into mixing bowl the flour, baking powder, and salt. Cut in shortening. Add milk and mix until dry ingredients are wet. Knead on pastry board 30 times before rolling out to ½ inch thickness. Cut biscuits with a 2-inch cutter. Bake at 450° F. for 8 to 10 minutes on an ungreased baking sheet.

TABLE 6

Ranking, by taste panel, of biscuits prepared from bread flour

Test no.	Megarep dose	0	0.03	0.1	0.15	p	Sign. dif.?
1.	Score	25	29	28	26	.70	No
2.	Score	19	18	17	18	.96	No

TABLE 7

Characteristics of biscuits made with irradiated bread flour

Dose, rep	
0	Even-grained, tender, light cell walls, most tender outer crust.
20,000	Coarse and close textured, not as "light."
50,000	Lighter, more tender, not as close texture, not quite equal to control.
100,000	Slightly gray crumb color, light cell wall structure, most tender of irradiated biscuits.
150,000	Coarser texture, more compact, not as tender, slightly darker crumb color.

Although there were no marked changes in the baking qualities of bread flour exposed to gamma radiation between 20,000 and 150,000 rep, there were some noticeable flavor changes. It seemed to some of the judges that the off-flavor of irradiated flour was accentuated by the presence of double-action baking powder. Not enough taste panel data were available to make any definite conclusions, but some of the panel members did not care for the flavor and eating qualities of the biscuits made with irradiated flour.

C. Bread

While studying the baking characteristics of irradiated bread flour, it was decided to make some tests with bread. The formula and method used are shown in Table 8. Bread was baked

TABLE 8

Formula developed for use in making bread with irradiated flour

Ingredients	
Milk scalded	1 c
Water	½ c
Shortening	2 T
Yeast	½ oz
Sugar	1 T
Salt	2 tsp
Flour, sifted	4 c, approximately

Method. Dissolve yeast in water (110° F.). Pour scalded milk over shortening, sugar, and salt. When the milk mixture is lukewarm (80-85° F.), add the yeast mixture. Add flour gradually. Knead dough 5 or 6 minutes until smooth, then place in a well-greased bowl and allow to rise from 1 hour 15 minutes to 1 hour 30 minutes. Knead dough again for 3 or 4 minutes; then allow to rise again for 45 to 60 minutes. Knead dough again for 1 minute; then shape it to fit the bread pan which is well greased. Allow dough to rise in the pan until slightly more than double in size. Bake for 30 minutes at 400° F. and 20 minutes at 350° F. Yield: one (9 x 5 x 3) loaf.

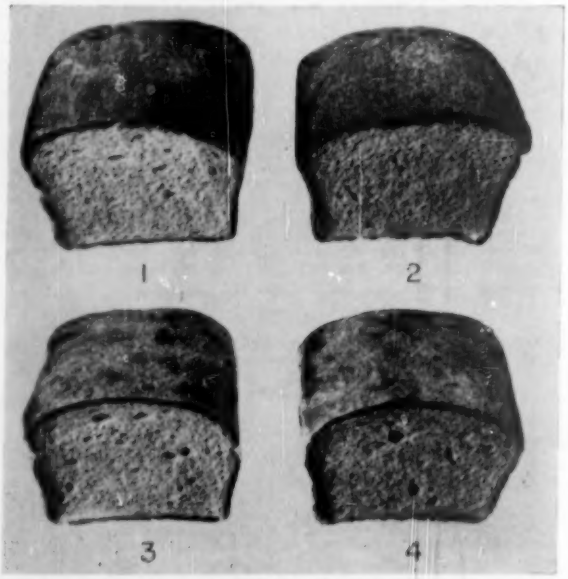

Figure 4. Bread made with irradiated bread flour; control, 200,000, 500,000, 1,000,000 rep, respectively.

TABLE 9

Ranking, by taste panel, of bread prepared from bread flour

Test no.	Megarep dose	0	0.20	0.50	1.0	P	Sign. dif.?
1.	Score	24	25	28	31	.19	Yes
2.	Score	19	20	22	29	*	No
	Preference	.44	.34	.20	.02		

* Less than 0.01.

with flour that had been exposed to 200,000, 500,000, and 1,000,000 rep gamma radiation and a nonirradiated control. Figure 4 shows sections of loaves of bread made with these flours.

Taste panel results are shown in Table 9. The judges had a slight preference for the nonirradiated loaf and those made from flour given 200,000 and 500,00 rep. However, the flavor of the control was definitely preferred to the loaf made with flour given a dose of 1,000 000 rep. Bread from the latter loaf was considered to have a definite off-flavor.

CONCLUSIONS

Cake flour, all-purpose flour, and bread flour are not changed when given a dose of 20,000 rep gamma radiation. At 20,000 rep flour insects and weevils would be destroyed and insect eggs would be made sterile. Cakes made with these different flours given this radiation dosage were similar to the controls in all respects.

Bread flour given a dose higher than 50,000 rep is not improved. Cakes made with irradiated bread flour were progressively of poorer quality with increasing doses of gamma radiation. Cakes made with irradiated flour had low total volume, were heavier, more compact, gummier, and had a darker yellow crumb color. The gluten appears to lose its binding power and the flour has a drier or more starch-like texture in mixing. Flavor changes were noticeable in cakes made with bread flour given a dose of 100,000 rep. The cakes, particularly the crusts, have a sweeter flavor. Off-flavors were noticed with higher doses of irradiation.

When making biscuits with irradiated flour receiving 20,000 to 150,000 rep, it was necessary to add 10 cc. more milk to obtain a workable dough. This dryness of irradiated flour was also noticed when mixing cakes. Biscuits made with irradiated flour had a satisfactory appearance but the eating qualities and flavor were not equal to those of the controls. The biscuits made with irradiated flour were gummier and off-flavors were present in samples made with flour given dosages greater than 20,000 rep.

Aside from total volume, which was slightly smaller in the bread made with 20,000 rep bread flour, the loaves made with flour given this dosage were equal in all respects to those made with the nonirradiated flour. Loaves made with flour given 5×10^5 and 10^6 rep had a smaller volume and crumb color was comparable to honey bread.

A radiation facility was designed to irradiate 27.2 tons per hour of flour, grain, or meal in 100 pound bags. The design features a radiation chamber 11 feet high (outside dimensions) by 37 x 10 feet plus an extension of 7 x x12 feet for a well. The well is 16 feet deep and is filled with water. Lowering the radiation source into the well permits entry into the radiation chamber for routine inspection and maintenance. Transfers of the radiation source would be made in the well under water.

In this design the chamber is located below grade so as to take advantage of shielding provided by the earth. These features of the design reduce the estimated cost for the radiation chamber (including the conveyor) to $38,320, which is the lowest estimate of 7 different designs of commercial radiation facilities that have been considered by the authors.

Two cooling reactor fuel elements were selected as the source of radiation because of the present unavailability of fission products in a form suitable for industrial use. These elements would be replaced 6 times yearly to maintain the radiation field. The estimated costs for operation including rental and transportation of the fuel elements were $42,240 per year. Using a schedule for operation of 260 days per year with 8 hours per day, the cost of irradiation was estimated to be about $5.66 per ton.

This study indicated that the irradiation of flour, grain, or meal for control of insect infestation is feasible both from the standpoint of the effects of radiation on the baking quality and of cost.

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Compatibility of Sodium Ascorbate and Sodium Nitrite in Meat Curing Mixtures[a,b]

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(Manuscript received July 29, 1955)

The quantitative influence of pH, salt concentration, temperature and other factors on the compatibility of sodium ascorbate and sodium nitrite in dry curing mixtures and in solutions is reported.

The nitrates and nitrites of sodium and potassium are added to meat during the conventional curing process to serve as sources of nitric oxide. Nitric oxide in turn combines with the fresh meat pigments to form, when heated, the more stable, red pigments of cured meats. Increased yields of nitric oxide from nitrites and nitrates are obtained in the curing process by the action of reducing agents. Obviously an increased yield of nitric oxide is desirable since it accelerates and to some extent insures the formation of the cured meat pigments. The reducing agents, ascorbic acid and sodium ascorbate, serve this purpose, i.e., they are added to meat products during curing for several reasons, one being to insure increased yields of nitric oxide from nitrite *(3, 5, 6)*. This use of ascorbic acid and sodium ascorbate in curing of pork and beef products has been approved by the Meat Inspection Branch of the Department of Agriculture *(4)*.

Following the general pattern of any development, the use of ascorbic acid or sodium ascorbate in conjunction with sodium nitrite in meat curing has brought forth some technical problems. It is the purpose of this report to discuss one of these problems; namely, the compatibility of sodium ascorbate and sodium nitrite in meat curing mixtures prior to and during the curing process. For example, sodium ascorbate may be mixed with sodium nitrite in either dry or wet curing mixtures. Since sodium nitrite and sodium ascorbate will react in solution, it is important that the reaction be controlled to assure maximum benefit at the proper time in the curing process. Obviously it is desirable to minimize the reaction between the two substances until they are in contact with, or dispersed throughout meats.

The use of sodium ascorbate in curing mixtures for hams, bacon, and corned beef brings this particular compatibility problem into sharp focus. For example, it is desirable to prepare dry curing mixtures containing both sodium nitrite and sodium ascorbate for use, as is in dry curing or in the subsequent preparation of pumping and cover pickles. Furthermore, the preparation and use of curing pickles themselves necessitates that sodium ascorbate and sodium nitrite are in contact in solution prior to and during the curing.

In dry mixtures containing sodium nitrite and sodium ascorbate, factors such as moisture content and storage temperature are important to the stability of the mixture. In curing solutions, pH and salt concentration in addition to temperature influence the rate of reaction between sodium nitrite and sodium ascorbate, and consequently determine the compatibility of these two substances. The quantitative influence of these factors on the compatibility of sodium nitrite and sodium ascorbate in dry mixtures and in solutions are herein reported.

METHODS OF ANALYSIS

One of the problems associated with the use of sodium ascorbate in curing mixtures containing sodium nitrite is to prevent the reaction of these compounds while in the presence of each other during the actual analysis. Otherwise the results would not represent the true situation existing at the time the product was sampled. Modifications of the usual methods of analysis for sodium ascorbate and for sodium nitrite were developed to circumvent this problem. These modified methods are described in the following:

Sodium ascorbate. The determination of ascorbic acid by direct titration with indophenol *(2)* was adapted for use in the presence of sodium nitrite. It is general practice in the indophenol titration to acidify the sample solution with metaphosphoric or other acids to give a sharper end point in the titration. With samples containing both ascorbic acid and sodium nitrite, however, it is undesirable to acidify the sample since the nitrite and the ascorbate would react at a very rapid rate during the actual titration. By omitting the acidification and controlling the pH of the sample within the range of 6 to 7 the reaction between ascorbate and nitrite during the titration is negligible. Titration of samples in this pH range gives a blue end point.

The analyses for ascorbic acid or sodium ascorbate are conducted then by adding a solution of the sample to a phosphate buffer in the pH range of 6-7, and titrating with indophenol to the blue end point. If a lapse of time occurs between sampling and assay, it is desirable to buffer the sample to pH 6 to 7 and keep it refrigerated to minimize the nitrite and ascorbate reaction.

Sodium nitrite. The AOAC method *(1)* for the determination of sodium nitrite in meat products was adapted for use in these studies. Following the procedure described for ascorbic acid the pH of the sample solutions were kept in the range of 6 to 7 to minimize the reaction between the ascorbate and nitrite prior to and during the analyses. The determination of sodium nitrite, however, necessitates its conversion to nitrous acid under acid conditions for the diazotization of sulfanilic acid. To minimize the possible reaction between ascorbate and nitrite while the solution was acidic, it was found necessary to add a mixture of sulfanilic acid, α-naphthylamine hydrochloride, and hydrochloric acid, described in the AOAC procedure, as one reagent. When the combination reagent was used, the diazotization and the linking of the diazo compound to form the colored compound occurred with little or no reaction between the sodium nitrite and the ascorbate.

An illustration of the improved assay for sodium nitrite in solutions containing sodium ascorbate by use of the combined reagent is shown in Table 1.

A corned beef pickle containing sodium nitrite and sodium ascorbate was assayed for sodium nitrite by the AOAC procedure, with and without combining the diazotizing and color forming reagents. The data in Table 1 show that about 15 to 22% of the nitrite is lost during the analysis if the regular procedure using separate additions of reagents is used. The use of the combined reagent prevents this loss.

[a] Presented at the Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 13, 1955.

[b] Contribution of the Research Laboratories, Chemical Division, Merck & Co., Inc., Rahway, N. J.

TABLE 1

Improvement in analyses for sodium nitrite in presence of ascorbate by combining the diazotizing and color formation steps

Sample	Ascorbate added	Sodium nitrite content (% of theory)	
		Separate additions	Combination reagent
1	None	106	100
2	None	104	97
3	None	106	100
4	Sodium Ascorbate	85	95
5	Sodium Ascorbate	78	95
6	Sodium Ascorbate	82	95
7	Ascorbic Acid	84	99
8	Ascorbic Acid	84	99
9	Ascorbic Acid	88	102

FACTORS INFLUENCING THE COMPATIBILITY OF SODIUM NITRITE AND SODIUM ASCORBATE

Dry curing mixtures. Probably the two most important factors influencing the stability of sodium nitrite and ascorbate in dry curing mixtures are moisture and temperature. It seems reasonable to assume that if mixtures are kept absolutely dry, little or no reaction between the sodium nitrite and ascorbic acid will occur even at low pH. However, when moisture is present the pH of the mixture becomes an important factor in determining the reaction rate between nitrite and ascorbate. For this reason sodium ascorbate rather than ascorbic acid is recommended for use in dry curing mixtures since it is difficult to keep mixtures absolutely dry under use conditions.

The effects of moisture and temperature on the relative stabilities of sodium nitrite and sodium ascorbate in a dry curing mixture are illustrated in Table 2. The effect of pH of the mixture on the compatibility of the two substances in the same dry curing mixture after moisture absorption is shown in Table 3. The dry curing mixture used in these tests comprised 52.7% salt, 43.8% sucrose, 2.16% sodium nitrate, 0.25% sodium nitrite and 1.09% sodium ascorbate. Samples of this mixture were buffered at different pH levels and stored under the accelerated condition of 80° F. and 65% R.H. in the tests shown in Table 3.

As heretofore suggested the data in Table 2 show that sodium nitrite and sodium ascorbate are compatible in dry mixtures at pH 5.7 as long as the mixtures are kept dry. The sodium ascorbate reacts with the nitrite in the curing mixture, however, when the mixture absorbs moisture. As would be predicted the reaction proceeds at a relatively slow rate when the mixtures are refrigerated even though the humidity and the moisture uptake are high. The data in Table 3 show that at pH 4.0 both nitrite and ascorbate are lost at a fairly rapid rate when the curing mixtures are stored under accelerated conditions of storage, i.e., 80° F. and high humidity. At pH 5.7, the usual pH when sodium ascorbate is used, the nitrite and ascorbate are more compatible, although eventually both are lost due to reaction. There was little difference in these tests in the rate of loss of ascorbate at pH 5.7 and at pH 6.4. However, nitrite appeared to be lost at a slower rate at the higher pH.

TABLE 2

Effect of moisture and temperature on the compatibility of sodium nitrite and sodium ascorbate in a dry curing mixture pH 5.7

Days storage	% Retention					
	80° F.				40° F.	
	Dry		60% R.H.		100% R.H.	
	Nitrite	Ascorbate	Nitrite	Ascorbate	Nitrite	Ascorbate
1	....	....	63	81	100	100
2	....	....	61	73	100	100
4	....	....	22	49	85	88
7	....	....	5	39[1]	93	72
14	100	100	....	....	66	62[2]
30	100	100	....	....	....	....

[1] Absorbed 9.3% moisture.
[2] Absorbed 13.8% moisture.

TABLE 3

Effect of pH on compatibility of sodium nitrite and ascorbate in dry curing mixtures at 80° F. and 65% R. H.

Days storage	% Retention					
	pH 4.0		pH 5.7		pH 6.4	
	Nitrite	Ascorbate	Nitrite	Ascorbate	Nitrite	Ascorbate
1	37	50	63	81	82	78
2	11	45	61	73	70	66
4	10	33	22	49	54	61
7	0	26	5	39	....	....

It was interesting to note that during these storage tests the mixtures showing reaction between ascorbate and nitrite turned pink in color, the depth of the color depending on the extent of the reaction. The controls, on the other hand, either those stored under dry conditions or those without ascorbate, remained white throughout the storage period.

It can be concluded generally from these tests that dry curing mixtures containing sodium nitrite and sodium ascorbate can be prepared with reasonable surety of stability during dry storage. Recommended storage conditions for such curing mixtures would be cool, dry conditions preferably in polyethylene lined drums.

Curing pickle. The major factors determining the compatibility of sodium nitrite and ascorbate in curing solutions are concentration of ingredients, pH, and temperature. The results of storage studies on curing solutions of various compositions showing the influence of these factors on the compatibility of sodium nitrite and sodium ascorbate are shown in Tables 4, 5, and 6.

In one series of tests a ham curing pickle comprising 17% salt, 2.4% sucrose, 0.12% sodium nitrate, 0.18% sodium nitrite and 0.5% ascorbate was prepared. The solution was buffered with a combination of sodium phosphates to the desired pH levels. The data in Table 4 show the effects of pH on the stability of sodium nitrite and sodium ascorbate in this curing pickle stored at 40° F.

In a second series of tests the stability of sodium nitrite and sodium ascorbate was determined in a commercial corned beef pickle solution. In this particular curing solution, in contrast to the ham pickle, the concentration of sodium ascorbate was very low and the concentration of sodium nitrite was roughly three times that of sodium ascorbate. The composition of the solution was 17% salt, 1.5% sucrose, 0.6% sodium nitrate, 0.15% sodium nitrite and 0.05% sodium ascorbate. The stability of these ingredients was determined at the natural pH of 6.0 and the results are shown in Table 5.

TABLE 4
Effect of pH on the compatibility of sodium nitrite and ascorbate in curing pickle at 40° F.

Days storage	% Retention									
	pH 5.6		pH 6.2		pH 6.5		pH 6.9		pH 7.3	
	Nitrite	Ascorbate	Nitrite	Ascorbate	Nitrite	Ascorbate	Nitrite	Ascorbate	Nitrite	Ascorbate
1	69	66	93	89	100	100	98	99	100	97
2	61	49	80	79	92	97	100	99	100	92
4	46	41	83	74	98	91	98	94	98	86
7	35	37	74	63	100	85	100	88	100	80

In a third series of tests the influence of concentration of salt (the degrees salometer) on the stability of sodium nitrite and ascorbate in a ham curing pickle was determined. These data are shown in Table 6. The composition of the curing pickle in these tests was 2.4% sugar, 0.12% sodium nitrate, 0.18% sodium nitrite, 0.1% ascorbate and varying levels of salt.

The data in Table 4 show that in the pH range of 6.5 to 7, little or no reaction occurs between the sodium nitrite and sodium ascorbate in curing pickle during refrigerated storage for 7 days. On the other hand, at lower pH's the sodium nitrite and sodium ascorbate appear to react slowly and the concentration of both diminish during the 7 day storage period. At pH above 7 the nitrite appears to be perfectly stable, but the ascorbate appears to be oxidized, presumably due to its reaction with dissolved air.

The data in Table V indicate that when the concentration of ascorbate is relatively low, as used in corned beef pickle, the nitrite is relatively more stable than the ascorbate. This is true at pH 6.0 which is slightly below the optimum pH for maximum stability for both ingredients. The ascorbate in a corned beef pickle is relatively stable, however, under refrigerated conditions for 5 days.

The concentration of salt in curing solutions has some influence on the stability of ascorbate. It is well known that addition of salt to a solution of ascorbic acid has a tendency to stabilize ascorbic acid against oxidation. The data in Table 6 illustrate this point by showing that increasing the salt concentration in curing pickle tends to decrease the loss of sodium ascorbate. The reaction with sodium nitrite is probably the major reaction causing the loss of ascorbate at pH 5.5 and the direct oxidation of the ascorbate with air is the major reaction at pH 7.0.

The overall conclusion may be drawn from these data that curing solutions can be prepared and stored under refrigerated temperatures for a few days with insignificant loss in nitrite and ascorbate, providing the pH of the pickle is kept in the 6.5 to 7.0 range.

TABLE 5
Compatibility of sodium nitrite and sodium ascorbate in a commercial corned beef pickle, pH 6.0

Days	% Retention			
	40° F.		80° F.	
	Nitrite	Ascorbate	Nitrite	Ascorbate
1	100	93	100	79
2	100	90	100	65
5	....	78	....	41
7	....	58	....	10
14	100	0	100	0

TABLE 6
Stability of ascorbate in curing pickle at 40° F. with increasing concentration of salt

Storage time (hours)	% Ascorbic retention							
	Without Salt		7% Salt		15% Salt		22% Salt	
	pH 5.5	pH 7.0	pH 5.5	pH 7.0	pH 5.5	pH 7.0	pH 5.5	pH 7.0
3	45	88	54	....	76	94	76	95
6	15	....	16	90	17	90	38	93
24	0	79	0	81	0	82	15	....
96		37		....		....		83
144		0		56		68		77

SUMMARY

In view of the increasing use of ascorbic acid and sodium ascorbate as reducing agents in meat curing mixtures, factors influencing the compatibility of these compounds with sodium nitrite were studied. Conditions of moisture and temperature were found to be important in controlling the reaction rate between ascorbate and nitrite in dry curing mixtures. When such mixtures were kept dry and cool, the nitrite and ascorbate were found to be compatible. In wet curing mixtures, either dry mixtures after moisture uptake or in curing solutions, concentration of ingredients, pH, and temperature determined the rate of reaction between ascorbate and nitrite. Curing pickles with a high concentration of salt, in pH range of 6.5 to 7.0 and stored under refrigeration showed very slow reaction between ascorbate and nitrite. Under more acid conditions and at higher temperatures the two ingredients react quite rapidly.

By controlling the pH of the sample within the range 6 to 7 during the titration with indophenol a more accurate analysis of ascorbate in the presence of nitrite was obtained than when the usual acidification procedure was used. By combining the diazotization and color forming steps in the AOAC analysis for nitrite a more accurate assay for nitrite in the presence of ascorbate was obtained.

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Nonenzymatic Browning and Sulfite Flavor in Dehydrated White Potato. Effects of Sulfite Level and Method of Sulfite Application[a]

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Nonenzymatic browning and intensity of sulfite flavor in dehydrated potato dice have been studied as a function of method of sulfite application. Effects of moisture and sulfite levels on browning have also been studied.

Although dehydrated diced potatoes have received much study, effects of certain variables have not been clarified. One such variable is method of sulfite application. In many instances the presence of sulfite is not desired, but in others, particularly in dice for military use, sulfite is needed for stability of the dehydrated product against nonenzymatic browning under adverse storage conditions that may be encountered. An inquiry from the Quartermaster Food and Container Institute for the Armed Forces regarding effects of method of sulfite application stimulated the following work.

Sulfite is applied during manufacture by one of two methods: spraying the product with a solution of sulfite salts before drying in indirect-heated driers or absorption of sulfur dioxide from combustion gas in direct-fired tunnels. The combustion gas sometimes has a higher sulfur dioxide content than desired and the sulfite content of the product has sometimes been above the Armed Forces specification range of 200 to 500 p.p.m. *(6)*. It has been a question whether the sulfite flavor is as strong in gas-sulfited product as in the spray-sulfited material. Another question has been on the relative degree of protection against nonenzymatic browning. These effects have been studied together with the effects of moisture and sulfite levels on browning during storage.

PREPARATION OF MATERIALS

Most of the dehydrated potatoes used in this study were prepared at the Caldwell, Idaho, plant of the J. R. Simplot Co. Because of the large effect of reducing sugars on rate of browning, two lots of raw material were used, one "low sugar" (1.7% reducing sugar and 2.2% total sugar, moisture-free basis), the other "high sugar" (3.8 and 4.9% reducing and total sugars, respectively). The sugars were determined on extracts clarified by ion exchange resin treatment *(12)*. The potatoes were lye-peeled, trimmed, cut to ⅜ x ⅜ x 3/16-inch "half-dice," steam blanched, and then placed on trays at a loading of 1½ lbs./sq. ft. (27 pounds per 3 x 6-foot tray). Part of these blanched dice were then dried in direct-fired counterflow tunnels; the remainder, still on trays, were dried in an indirect-heated drier. For two of the tunnels, the sulfite level of the combustion gases was increased by injecting sulfur dioxide gas at measured rates into the inlet air. For the potatoes dehydrated in the indirect-heated drier, sulfite solutions were sprayed on the blanched dice before they were placed in the drier. With some of these trays the solutions were "concentrated" (0.6 to 1.0% sulfite salts) and only a small amount of solution was used (weight of solution equal to 7% of the weight of the blanched dice). With other trays the solutions were "dilute" and the amount of solution was relatively large (60% of the weight of the dice, for solutions containing 0.1 to 0.3% sulfite salts). These quantities of solution cover approximately the range that has been observed in commercial dehydration operations. The solutions contained equal weights of sodium sulfite and sodium bisulfite and had a pH of 6.6 ± 0.1. The solutions were applied by atomizing sprays.

Drying in the indirect-heated drier was at a dry-bulb temperature of 140° F. (60° C.) and a wet-bulb temperature of 75 to 80° F. (24 to 27° C.); drying time was 4½ hours. For the tunnel the inlet air was 160° F. (71° C.) and the exhaust air approximately 100° F. (38° C.), with a wet-bulb temperature of approximately 90° F. (32° C.). Drying time was 7 hours. The samples were nitrogen packed and then held at 34° F. (1° C.) until subsequently used in the sulfite tasting or nonenzymatic browning tests.

Certain lots of dehydrated dice were also prepared in the pilot plant at this laboratory with sulfite application by spray before drying, or by sulfur dioxide gas added to the drying air. Sulfite content was determined by formaldehyde titration *(7)*.

NONENZYMATIC BROWNING

For storage tests, portions of the dice were adjusted by vacuum desiccation to moisture levels of 7 and 4% [6-hour vacuum oven method, as-received basis, *(6)*]. One-hundred-gram portions were sealed (air-packed) in 211 x 400 cans and placed in storage at 100° F. (38° C.). Samples were removed periodically and the amount of nonenzymatic browning was measured by a new soluble color procedure that has been described recently *(3)*. Optical density values were plotted against storage time; data from the resulting smoothed curves are given in Table 1. Typical curves are shown in Figure 1.

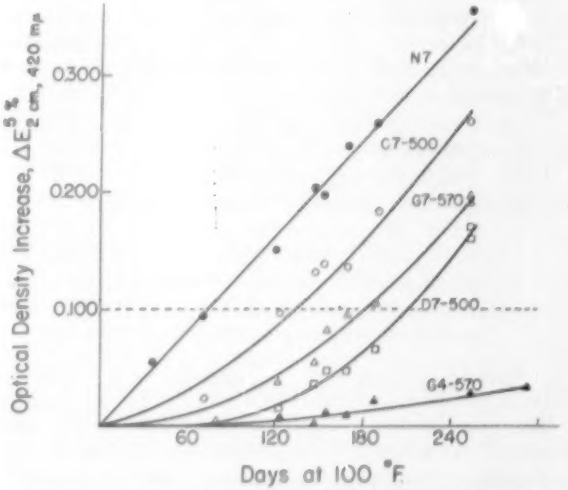

Figure 1. Effect of processing variables on nonenzymatic browning of low-sugar dehydrated diced potato at 100° F. (38° C.). N7, non-sulfited, 7.0% H_2O; C7-500, concentrated sulfite spray, 7.0% H_2O, 500 p.p.m. SO_2; G7-570, gas-sulfited during drying, 7.0% H_2O, 570 p.p.m. SO_2; D7-500, dilute sulfite spray, 7.0% H_2O, 500 p.p.m. SO_2; G4-570, gas-sulfited during drying, 4.0% H_2O, 570 p.p.m. SO_2.

[a] Presented at the Fifteenth Annual Meeting of the IFT, Columbus, Ohio, June 12-16, 1955.

The data show that for comparable moisture, sugar and sulfite levels, samples sulfited with dilute spray had somewhat better resistance to browning than the other samples. It had been expected that a dilute spray might give better protection than a concentrated spray; the larger volume would insure a more uniform sulfite distribution so that most, if not all, of the dice would have the protection of the sulfite. Possible explanations of the lower protection afforded by gas-sulfiting are that the distribution may have been less uniform, or that incipient heat damage may have occurred in these samples in the course of their slower drying. As a result of this observation, the possibility that incipient heat damage may occur in white potatoes during drying is being studied at this Laboratory.

The browning plots (Figure 1) are similar in shape to those reported previously *(4, 5)*; that is, they are approximately straight lines for nonsulfited dice and curves concave upward for the sulfited. The plots show, again in accord with previous reports, that sulfite is quite effective in retarding browning in its early stages, for example for optical density increases of less than about 0.020 unit, but that it becomes progressively less effective as browning proceeds. Also in accord with previous results *(5)*, very effective protection against browning was obtained by the combination of sulfite and low moisture (4%).

The effect of sulfite level is interesting. Increasing the sulfite was being studied as a possible method of increasing protection against browning. Contrary to expectation, increasing the sulfite level from about 400 p.p.m. to about 1,000 p.p.m. was far less effective than lowering the moisture from 7.0 to 4.0%. The results thus indicate that increasing the sulfite beyond present Armed Forces' specification levels would not very effectively increase protection against browning. Other methods now seem to offer greater promise. Lower moisture can be achieved by cutting the pieces thinner (e.g., to ⅛-inch thickness instead of $\frac{3}{16}$-inch), with calcium chloride addition to avoid sloughing *(8)*. Also Simon *et al. (9)* have recently shown that calcium chloride itself contributes to protection against browning, especially when used in combination with sulfite within Armed Forces' specification limits.

TABLE 1

Effects of method of sulfite application, sulfite level, and moisture content on browning of dehydrated white potatoes at 100° F.

Method of application	SO_2 p.p.m. (initial)	H_2O %[1]	Optical density increase[2] × 1,000 2 months	4 months	6 months
Low-sugar potatoes					
SO_2 gas during drying	570	7	10	40	100
SO_2 gas during drying	570	4	0	5	10
SO_2 gas during drying	870	7	0	15	55
SO_2 gas during drying	870	4	0	5	15
Spray, dilute	200	7	5	70	160
Spray, dilute	500	7	0	15	60
Spray, concentrated	500	7	30	85	160
Spray, concentrated	730	7	10	65	130
Spray, concentrated	730	4	5	10	15
No sulfite	0	7	80	160	245
High-sugar potatoes					
SO_2 gas during drying	400	7	165	625	....
SO_2 gas during drying	400	4	20	45	....
Spray, dilute	330	7	85	455	....
Spray, dilute	430	7	80	430	....
Spray, dilute	700	7	20	280	....
Spray, concentrated	480	7	140	590	....
Spray, concentrated	700	7	75	490	....
Spray, concentrated	700	4	0	15	....
Spray, concentrated	1000	7	30	300	....
No sulfite	0	7	280	720	....

[1] Six-hour moisture method, "as received" basis *(6)*.

[2] Optical density measured in a 2-cm. cell at 420 mμ; 5 grams potato per 100 ml. of clarified water-acetone solution *(3)*. An optical density increase of 0.100 corresponds to the arbitrary "limit of palatability" previously selected *(4)*.

EVALUATION OF SULFITE FLAVOR

The dice (50 g.) to be used for flavor evaluation were soaked for an hour in 8 times their weight of distilled water at room temperature and then boiled for 15 minutes and drained before submission to the judges. Four groups of samples were scored by 7 trained, selected judges on a scale of 7 to 1. Score 7 indicated no sulfite flavor and score 1 indicated much. The groups of samples were as follows:

(1) Low-sugar potatoes: SO_2 gas to give 870 and 570 p.p.m. and dilute spray to give 510 p.p.m. SO_2 in the dehydrated dice.

(2) Low-sugar potatoes: same as (1) except concentrated spray to give 730 p.p.m. SO_2.

(3) High-sugar potatoes: gas to give 760 and 410 p.p.m. and dilute spray, 700 p.p.m. SO_2.

(4) High-sugar potatoes: same as (3) except concentrated spray to give 600 p.p.m. SO_2.

Because previous work *(1)* had shown that intensity of sulfite flavor decreases as successive portions of potatoes containing a constant amount of sulfite were tasted, this effect was equalized by presenting the three samples of one group in all possible orders: ABC, ACB, BAC, BCA, CAB, CBA. The order for a given day was randomized among the six taste sessions required to evaluate the group of samples. Instructions to judges were as follows: "Taste in the order presented. Do not retaste any sample. Use a water rinse between samples. Wait half a minute between the water rinse and the next sample. Do not swallow any potato." The scores were treated statistically by the analysis of variance [*Snedecor (10)*].

As expected, the order in which a given sample was tasted usually had a large effect on its score. The score was lowest (most intense sulfite flavor) when the sample was the first one tasted. Bias due to this effect, however, was apparently eliminated by the choice of experimental design. In only one of the four groups of samples mentioned above was there found a difference in average scores significant at the 5% level of probability. In group 3 the sample containing 700 p.p.m. applied as a dilute spray was scored significantly lower than the gas-sulfited sample containing 410 p.p.m. SO_2. However, since it was not different from the gas-sulfited sample containing 760 p.p.m. SO_2, the observation does not constitute evidence that the method of sulfite application, by itself, made a difference in the intensity of sulfite flavor.

The fact that gas-sulfited samples containing 410 and 760 p.p.m. SO_2 were not found significantly different indicates that the panel was relatively insensitive to differences in sulfite concentration. Studies by other workers *(2, 11)* also suggest that at sulfite levels well above the sensory threshold, judges have difficulty in estimating the intensity of sulfite flavor.

SUMMARY

No statistically significant difference in the intensity of sulfite flavor was found between samples sulfited by spray before drying or by sulfur dioxide gas during the drying. The sulfite intensity was affected but little by variations in sulfite level.

Sulfite applied as a dilute spray gave somewhat better protection against nonenzymatic browning than either a concentrated spray or gas-sulfiting during drying. Possible reasons are discussed.

The marked protection against nonenzymatic browning attainable by low moisture in combination with sulfite was again demonstrated. Increasing the sulfite level from about 400 p.p.m. to as high as 1,000 p.p.m. gave somewhat increased protection against browning, but much greater protection resulted from lowering the moisture content from 7 to 4%.

Acknowledgments

Appreciation is expressed to the J. R. Simplot Co. and to members of its staff, in particular Ray W. Kueneman and Leon C. Jones, for cooperation and use of facilities at their Caldwell, Idaho, plant in preparing samples used in the present study. The authors also wish to thank members of the taste panel for their cooperation.

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Preparation and Storage of Canned Berry and Berry-Apple Pie Fillings[a,b]

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Formulae for high quality berry, and berry-apple ready-to-use canned pie fillings are presented together with a suggested method of processing. A number of thickening agents are discussed regarding their suitability as stabilizers. Data are presented indicating the probable shelf life of berry fillings stored at temperatures of 70° F., 85° F., and 100° F.

In 1952 a study was started on a new type of canned fruit pie filling. It was the intention to develop a product of high fruit content with good flavor and a minimum of stabilizer. A survey showed that this type of filling varied materially from commercial products then available on the market. The latter contained less fruit, more thickener and were generally low in color and flavor.

Recently a number of new stabilizers have become available for use by food processors. Some have yielded very promising results in the preparation of stable canned soup mixes, frozen puddings, sauces and gravies *(2, 3, 4)*. Information is available *(1, 5)* on their use in the preparation of fresh pies for the home and bakery trade. However, no references were found in the literature regarding the use of thickening or stabilizing agents in the preparation of canned fruit pie fillings.

Numerous investigators *(6, 7, 8, 9, 11, 12)* have studied the effect of storage temperatures on canned fruit products. High storage temperatures are known to exert a deleterious effect on color and quality. This is especially true in berry products high in anthocyanin pigments.

The objects of this investigation were:

1. To develop formulae for pie fillings of high fruit content (70-80%) from berries or a combination of berries and apple sauce.

2. To determine the relative stability of the berry and berry-apple fillings at different storage temperatures.

EXPERIMENTAL PROCEDURE

Pie fillings were made from commercially packed frozen fruit. The fruits used were blackberry, black currant, blueberry, loganberry, raspberry and strawberry (4 + 1).

The suitability of a number of thickening agents as stabilizers for fruit pie fillings was reported in a previous paper *(10)*. Further experimentation and preliminary tests on berry fillings resulted in a selection of the following for use in this investigation.

[a] Contribution No. 855 from the Division of Horticulture, Experimental Farms Service, Ottawa, Canada.

[b] Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 13, 1955.

1. Pregelatinized tapioca (Normal granulation and in smaller granulations of —20 and —40 mesh).
2. Waxy maize (Amaizo W-13 Stabilizer).
3. Fruit Pie Filling Starch: (A specially tailored corn starch found in experiments to behave very similarly to Amaizo W-13).
4. Clearjel.
5. Locust bean gum.
6. Carboxymethylcellulose.

Process. The process is premised on the use of as little water as possible and a total heating time not exceeding 6 minutes. The thawed berries, or berries and apple sauce, were mixed with 50-75% of the required sugar and heated to at least 190° F. (88° C.). The stabilizers dispersed in the balance of the sugar were sifted in with constant stirring and the mixture heated to 208-210° F. (98°-99° C.) This temperature was maintained for 1 minute to ensure complete "solubilization" of starch. Twenty-ounce lacquered cans were filled full at 200° F. or higher, inverted for 1 minute, and water cooled.

The fillings were stored at controlled temperatures of 0° F., 40° F., 70° F., 85° F., and 100° F. (—18° C., 4° C., 21° C., 29° C., and 38° C.) Samples for organoleptic examination were removed from temperatures above 70° F. (21° C.) at intervals of 1-2 weeks. Those stored at 0° F. and 40° F. (—18° C. and 4° C.) were examined when the quality of the 70° F. (21° C.) controls appeared to have deteriorated.

Examination for quality involved evaluation of the following: general appearance, color, fruit content, wholeness of fruit, texture of fruit, and consistency. Examinations were carried out before and after baking in two crust pies. Special note was made of thickener stability, especially at the lower temperatures. In judging consistency or set it was considered that a slight spread, or weep was desirable in a berry pie.

RESULTS AND DISCUSSION

Formulae and stabilizers for high quality fillings. The formulae presented in Tables 1 and 2 resulted in canned berry pie fillings of high quality. The fruit content of all fillings except blueberry and blueberry-apple ranged from 70-80%. With blueberry and blueberry-apple fillings the best texture, flavor, and consistency was obtained with fruit contents of 55% and 67% respectively. The soluble solids content of the fillings as determined by refractometer varied according to the fruit used as follows: blackberry, blackberry and apple, blueberry, blueberry and apple, raspberry, raspberry and apple, strawberry, 30-35%; black currant and apple, 42%; loganberry and apple, 36-40%. The pH ranged from 3.04-3.36.

None of the stabilizers used in this study had a deleterious effect on color or flavor. A combination of two or more usually produced the best results.

All fillings benefited from the addition of 0.1% locust bean gum. The gum imparted a gloss to the product and reduced excessive weeping where starch hydrolysis had occurred. Carboxymethylcellulose was substituted for locust bean gum in some formulations with comparable results.

The tapioca blends, either used alone or in combination with a modified corn starch, resulted in most attractive blackberry, loganberry, and strawberry fillings. The tapioca tended to absorb the color of the fruit and was almost indistinguishable from the unbroken drupelets.

Equal proportions of Amaizo W-13 Stabilizer and Fruit Pie Filling Starch produced the best black currant-apple and blueberry-apple fillings. In the latter, Clearjel can be substituted for either of the other two starches. In fillings from these fruits and Newberg raspberries the tapioca, especially the regular blend, tended to be too noticeable in the finished product.

Apple sauce, where it can be employed, permits a marked reduction in the amount of stabilizer required. When a highly colored, strongly flavored fruit, such as black currant is used, 60% of the total fruit content may be apple sauce without detracting appreciably from color and flavor. Up to 35% of the total fruit content of loganberry fillings can be apple sauce. With blueberry, because of its mild flavor, 18% is the maximum that can be employed.

Effect of elevated storage temperature on quality. The ability of berry fillings to withstand high temperature storage varies markedly with the type of filling. Table 3, Column A, indicates the number of weeks these products were stored at 70° F., 85° F., and 100° F. (21° C., 29° C., and 38° C.) before color or flavor loss could be detected. The actual shelf life at these temperatures would be somewhat longer than indicated in this column. (See Columns B and C).

Black currant-apple, blueberry, and blueberry-apple fillings were the least affected by elevated storage temperatures. The color change, when it could be detected, was a very slight purpling and dulling of the product as length of storage increased.

Raspberry and strawberry fillings were the most adversely affected by high storage temperatures. The

TABLE 1

Formulae for blackberry, black currant and blueberry fillings

Ingredients	Blackberry		Blackberry-apple		Black currant-apple				Blueberry		Blueberry-apple	
	Formula 1		Formula 1		Formula 1		Formula 2		Formula 1		Formula 1	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Fruit (Berry)	80	..	52	....	35	....	35	....	55	....	55	....
Apple sauce	....	....	28	....	35	....	35	....	....	....	12	8
Sugar	20	....	20	....	30	....	30	....	25	....	20	....
Water	....	....	....	....	....	....	....	....	20	....	12	8
Locust bean gum	....	1½	....	1½	....	3½	....	1½	....	1½	....	1½
Minute tapioca (regular)	1	....	....	8								
Minute tapioca (—20 mesh)	1	....	....	....								
Fruit Pie Filling Starch							.... 8 or 8				2 8 or 2 8 or 2 8	
Amaizo W-13 Stabilizer			....	8					2 8 or 2 8			
Clearjel												
Citric acid									....	1	....	1

TABLE 2
Formulae for loganberry, raspberry and strawberry fillings

Ingredients	Loganberry-apple				Raspberry		Raspberry-apple		Strawberry			
	Formula 1		Formula 2		Formula 1		Formula 1		Formula 1		Formula 2	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Fruit (Berry)	49	—	49	—	75	—	48	—	75	—	75	—
Apple sauce	26	—	26	—	—	—	32	—	—	—	—	—
Sugar	25	—	25	—	25	—	20	—	25	—	25	—
Water	—	—	—	—	—	—	—	—	—	—	—	—
Locust bean gum	—	1½	—	1½	—	1½	—	1½	—	1½	—	1½
Minute tapioca (regular)	1	—	—	10¾								
Minute tapioca (—20 mesh)	1	—	—	10¾								
	or											
Minute tapioca (—40 mesh)	1	—	—	—					1	11	2	8
Fruit Pie Filling Starch			—	10½	3	—	1	10	—	13		
			or		or		or		or			
Amaizo W-13 Stabilizer			—	10½	3	—	1	10	—	13		
Citric acid									—	1½	—	1½

former after 16 weeks at 70° F. (21° C.) were approaching borderline acceptability. The exact point of unsuitability for strawberry fillings was not determined but would probably be in the neighborhood of 8 weeks.

The varietal color of Newberg is a pale red and the flavor quite sharp or acid. The Washington and Willamette varieties are a dark red-purple in color and have a more pronounced flavor. Limited tests indicate that the acceptable storage life of fillings made from these two varieties would exceed that of Newberg by at least 2 weeks at 100° F. (38° C.).

The color retention of strawberry fillings stored at elevated temperatures can be markedly improved by the addition of 1.5-2.25% cranberry concentrate (36% solids). The amount of concentrate added should not exceed 2.25%, as higher concentration exerts a deleterious effect on flavor.

Effect of low temperature storage on quality. Limited examinations of berry fillings stored at 0° F. and 40° F. (—18° C. and 4° C.) for 23-36 weeks indicate excellent color and flavor retention in black currant-apple, blueberry-apple, blackberry-apple, and loganberry-apple fillings. Strawberry and raspberry pie fillings from 40° F. (4° C.) storage were slightly poorer in color and flavor than those from 0° F. (—18° C.) storage. Both, however, were much superior to samples from 70° F. (21° C.) storage.

No thickener breakdown[c] has been observed at the elevated storage temperatures. In some fillings at 0° F. and 40° F. (—18° C. and 4° C.) minor stabilizer breakdown did occur. After 23-36 weeks storage the breakdown occurs to the same degree at both temperatures.

Stabilizer breakdown is most pronounced in fillings having either a fruit content below 80% or those containing no apple sauce. Black currant-apple and blueberry-apple fillings showed no stabilizer breakdown. The all blueberry fillings (55% fruit) showed some syneresis and a soft "pumpkin like" set. Loganberry-apple filling, 75% fruit content, (65% loganberry and 35% apple sauce) showed slight syneresis. Syneresis was most pronounced in the all strawberry and raspberry fillings. Excessive syneresis detracted from the general appearance; but when the liquid phase was remixed with the solid, pies of good consistency resulted.

[c] Thickener breakdown referred to in this paper is analogous to syneresis in sugar-acid-pectin jelly.

SUMMARY

Formulae for improved quality berry, and berry-apple pie fillings, of high fruit content (70-80%) have been presented. In berry-apple fillings the percentage apple sauce depends upon the type of berry used.

Stabilizers resulting in highly satisfactory products consisted of modified corn and waxy maize type starches, tapioca (regular, —20 and —40 mesh) and locust bean gum. Clearjel could be substituted for Fruit Pie Filling Starch or Amaizo W-13 Stabilizer in some instances. Carboxymethylcellulose was used satisfactorily, in place of locust bean gum.

The storage life of the fillings at temperatures of 70° F., 85° F., and 100° F. (21° C., 29° C., and 38° C.) varies with the type of filling. Black currant-apple fillings are the most resistant to quality deterioration at

TABLE 3
Quality of berry pie filling as affected by length and temperature of storage

Type of filling	70° F.			85° F.			100° F.		
	A[1]	B[1]	C[1]	A	B	C	A	B	C
	wks.	wks.	wks.	wks.	wks.	wks.	wks.	wks.	wks.
Black Currant-apple	>36	—	—	>20	—	—	>6	—	—
Blackberry-apple	>23	—	—	10	12-14	—	>2	6	—
Blueberry-apple	>32	—	—	>32	—	—	3	>12	—
Loganberry-apple	>25	30	—	>8	8-12	25	3	4	6
Raspberry (Newberg)	<12	>16	<31	2-4	10	12	<2	3	—
Strawberry	>7	—	—	2-3	—	<6	<2	—	<4

[1] A = No appreciable change.
B = Borderline quality.
C = Unsatisactory quality.

elevated temperatures; raspberry and strawberry the least. Retention of color and flavor in all berry-apple fillings was excellent at 0° F. and 40° F. (—18° C. and 4° C.).

No stabilizer breakdown was observed at 85° F. and 100° F. (29° C. and 38° C.), but considerable syneresis was noted in some fillings stored at 0° F. and 40° F. (—18° C. and 4° C.).

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Deteriorative Changes in Frozen Shrimp and Their Inhibition[a,b]

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Data on changes which take place in shrimp during freezer storage are reported, and a method for inhibiting oxidative changes is described. It was shown, among other findings of interest, that ascorbic acid and liquid smoke act synergistically to inhibit oxidative changes.

The demand for shrimp has increased greatly over the past several years. Due to the fact that a large percentage of the consumers are geographically far removed from the Gulf and South Atlantic ports, and due also to the fact that the shrimp catch fluctuates somewhat with the seasons, the practice of freezing shrimp has become quite common.

The work described herein had two objectives: (a) to learn more about the basic changes which take place in shrimp and other seafood during freezer storage; (b) to develop a more satisfactory frozen cooked shrimp product. Such a product would be highly desirable from the consumer's point of view for rapid preparation of shrimp cocktail, shrimp salad, casseroles, and other shrimp dishes.

PREVIOUS INVESTIGATIONS

In an investigation on frozen cooked shrimp in 1947, Lewis *(13)* noted that loss of moisture and development of rancidity were the important changes taking place in frozen cooked shrimp. It was found that peeled boiled shrimp were acceptable when stored not longer than three months and unpeeled for not longer than six months. Moisture and water-proof containers were recommended.

Texture changes. Increasing toughness and dryness of fish products in freezer storage may be due to actual loss of moisture because of inadequate packaging or to protein denaturation resulting in shrinking of the protein structure and freeing of bound water from the tissue *(14, 15)*.

The development of toughness in frozen cooked shrimp was noted by Lemon *(12)*. It was suggested that cooking time be held to a minimum in order to prevent the condition. Garnatz, Vollé, and Deatherage *(7)* were issued a U. S. patent on the use of sodium phosphate or other alkaline salts as a soaking medium to be used prior to cooking the shrimp. The process is said to cut down on cooking loss as well as to promote tenderness in frozen shrimp. It is known that polyphosphates can retard coagulation of denatured protein *(11)*. Such compounds are being utilized to prevent loss of juice during cooking of hams *(1)*. Duerr and Dyer *(5)* working with cod muscle, showed that myosin denaturation is influenced by the concentration of sodium chloride in the tissues.

Oxidative changes. Color, flavor, and odor changes have been noted in addition to the texture changes and the three are apparently closely related.

The red color of cooked shrimp is due to a carotenoid pigment, astaxanthin. The literature on the carotenoids, including astaxanthin, is extensive and has been reviewed by Goodwin *(9)*. The early literature refers to astaxanthin as astacin. It is now evident that astacin

[a] This paper is taken from a dissertation submitted by Marian B. Faulkner to the Graduate Council, Florida State University, in partial fulfillment of the requirements for the degree of Doctor of Philosophy. The complete report is in the Florida State University library in Tallahassee.

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never occurs naturally and that reports of its presence are due to its formation by oxidation during the manipulative process.

There are two types of color change which occur in stored shrimp. The change which occurs first is the conversion of the original pinkish-red pigment to one of a more orange color. De Nicola *(4)* studying the carotenoids of a starfish *(Ophidiaster ophidianus)* identified a reddish-pink fraction (the major fraction) as astaxanthin and an orange-red fraction as astacin. The latter was thought to be an artifact produced during the extraction process.

The other color change occurring in stored shrimp is the gradual fading of the red pigment to an almost colorless state. In studies on frozen pink salmon *(3)* it was found that the normal pink to red color would fade and turn yellowish. Tarr *(17)* has stated that development of rancidity in salmon is accompanied by the bleaching of the red astacin pigments. This bleaching is apparently analogous to that which takes place when β-carotene is oxidized. As fat oxidizes with formation of peroxides, associated carotene is simultaneously oxidized and bleached *(16)*. It is therefore possible that the bleaching of astaxanthin, the carotenoid pigment of shrimp, is related to the oxidation of the fat present. However, the amount of fat is so small and so intimately associated with the protein that attempts to extract it in an unchanged condition for rancidity determinations were not successful. A method for colorimetric measurement of fading was therefore developed in order to obtain quantitative data on degree of oxidation.

Most of the anti-oxidants commonly used in foods have been investigated to determine their possible usefulness in inhibiting oxidative changes in shrimp. The primary anti-oxidants include gallic acid, butylated hydroxy anisole (BHA) and nordihydroguairetic acid (NDGA). Preliminary testing showed that gallic acid causes darkening of the white flesh of the shrimp. Neither BHA nor NDGA showed this disadvantage and both showed approximately equal protection against oxidation. Since BHA has the advantage of being less expensive, it has been investigated further.

Ascorbic acid has been widely used as a synergistic anti-oxidant. It is known to enhance the action of various phenolic anti-oxidants *(8)*. Tarr *(18)* has shown its value in preventing oxidative rancidity in fish.

A third anti-oxidant which has been investigated is liquid smoke flavoring. That at least one type of liquid smoke has anti-oxidant properties has been shown in tests with artificial systems, with frozen ground pork, and with fatty fish *(6, 19)*. The preparation has been further tested to determine whether or not it can prevent oxidative changes in shrimp. Although the characteristic shrimp flavor is altered by the addition of liquid smoke, smoked shrimp flavor seems to be desirable and there may be a market for a new type of smoked shrimp product.

Tarr *(17)* showed that sodium chloride can accelerate oxidation in frozen fish flesh. The same worker also showed that fillets dipped in ascorbic acid plus sodium chloride did not become rancid as rapidly as those dipped in the salt solution alone. Sodium chloride has been tested both alone and in combination with ascorbic acid in these studies.

EXPERIMENTAL

Shrimp used in the experiments were obtained from wholesale dealers at the docks in Apalachicola, Florida. For the most part, shrimp were obtained on the day the boat docked. Since the area covered by the fleet from Apalachicola is small and boats do not usually remain out more than 3 to 4 days, the shrimp were probably not more than 5 days old. Most of the shrimp were of the brown spotted variety, *Penaeus duorarum*. The remainder were white shrimp, *P. setiferus*. Shrimp were transported to Tallahassee packed in crushed ice.

Processing and testing procedures. The same general procedure was followed for processing all shrimp. Shrimp were cleaned, weighed, and then added to boiling water in an amount equal to the weight of the shrimp. The majority of the shrimp were cooked in 1000 g. lots. The various agents with which the shrimp were treated were added to the cooking water before the addition of the shrimp. BHA was dissolved in propylene glycol before addition to cooking water. The concentrations used were calculated as percent of cooking water. Heating was continued until the shrimp had been held between 85° and 95° C. for 5 minutes. At the end of the cook period, shrimp were drained, cooled, and packaged in 200 g. lots.

Samples of each experimental variation were removed from the freezer for organoleptic and colorimetric tests at designated intervals. Cooked shrimp were thawed by the addition of an equal weight of warm (80° C.) 2% NaCl solution. There were several exceptions to this procedure. The smoked shrimp were thawed in 4% NaCl solution. The shrimp which were cooked in sodium chloride to test the effect of the salt were thawed in warm water. Shrimp which had been frozen raw were allowed to thaw at room temperature, after which they were cooked according to the procedure described above.

Shrimp were judged for color, flavor, odor, texture and scored on a ten-point system. After the three-month testing period, it was decided that judging could be improved if judges were supplied a sample of fresh shrimp to use as a basis of comparison. Since it was difficult to obtain such small amounts of shrimp from wholesale dealers, shrimp from the local market had to be used.

When judges' scores indicated organoleptic differences, the number of preferences for each sample was considered. The significance of the differences was tested according to the chi-square method as described by Cover *(3)*.

Extraction of carotenoid pigment. Astaxanthin was found to be soluble in acetone and the following procedure was adopted for extraction of the pigment. One hundred grams of shrimp were put through a food grinder and thoroughly mixed; a 7 g. aliquot was blended with 10 g. Na_2SO_4 and 30 ml. acetone in a small metal Waring blender container for 2 minutes. The blend was filtered through filter paper (Schleicher & Schuell, Blue Ribbon, No. 589) into a 50 ml. volumetric flask and made to volume with washings. Duplicate extractions were made on all samples.

The absorption spectra of samples of filtrate from different lots of shrimp were measured on the Beckman recording spectrophotometer. Peak absorptions ranged from 473-477 mμ. The range in values is probably due to the fact that different extracts contained both astaxanthin and astacin in varying proportions. The above absorption maximum figures are confirmed by Goodwin's *(10)* value of 475 mμ for astaxanthin in acetone. Goodwin *(9)* has also shown that the maxima for astaxanthin and astacin differ only slightly and that total absorption is the same for both pigments. It is thus possible to treat the mixture containing varying amounts of the two as a single compound.

The absorption of various dilutions of the extracted pigment was measured on the Evelyn photoelectric colorimeter using a 470 mμ filter. The pigment obeyed Beer's Law. It has therefore been possible to make rapid quantitative measurements of the degree of fading using the colorimeter.

The original amount of pigment in different lots of shrimp can vary greatly. The white shrimp (that is, the white

variety) is less highly pigmented than is the spotted variety used in this investigation. Larger shrimp obviously contain less pigment per unit of weight than do small shrimp. The very end of the tail of the shrimp which is hard to retain in the peeling process is completely pigmented. In the experiments here reported, this portion was removed from all shrimp before the extraction process. A base line or original reading for each lot of shrimp must be established.

RESULTS AND DISCUSSION

In the first lot of experiments to be reported, quantitative pigment measurements were lacking. Organoleptic tests served as the only basis of comparison. Shrimp used in these experiments were headed and stored in the freezer (unshelled) for periods up to 20 days before processing. The freezer temperature, both before and after processing, was —4° C. Packaging materials differed. Some were packed in cellophane bags inserted in cardboard freezer cartons and some in paper bags inserted in waxed freezer cartons.

The experimental variables studied in these earlier experiments were (a) ascorbic acid in the cooking water and (b) raw versus pre-cooked frozen shrimp. Under the storage conditions described, marked deterioration of the control shrimp took place within the experimental storage times. In spite of the fact that it was not possible to retain the same group of judges throughout, subjective ratings agreed remarkably well and highly significant differences were obtained between the experimental variations.

Ascorbic acid definitely improved palatability (Table 1). After storage periods of 6 to 12 months and again after 18 or 19 months, judges indicated preferences for color, odor, and flavor of ascorbic acid treated shrimp. Texture of the treated shrimp received only slightly higher scores than did that of the control. As might be expected, the protective effect of ascorbic acid was confined to the oxidative changes.

Table 2 shows comparative scores on precooked and raw frozen shrimp. After short storage periods, precooked shrimp received the higher scores. Differences were greater and in the other direction after longer storage periods.

Because of the several uncontrolled factors in the foregoing experiments, a second group was planned to obtain additional data on the same factors but under less adverse storage conditions. In addition, several other antioxidants, polyphosphates and sodium chloride were included. The colorimetric method for measurement of fading was used along with organoleptic tests.

Differences in treatment with the second lot of shrimp were as follows: Shrimp were not stored in the freezer before experimental variations were set up. All samples representing variations were packed in polyethylene bags which were placed in individual waxed cardboard containers. After approximately 2 months' storage at —4° C. shrimp were transferred to a colder freezer (—18° C.). The same panel of 4 experienced judges was used for all taste tests.

In the later experiments atfer 10 months' storage, organoleptic scores were generally high for all samples; differences were in most cases negligible up to 10 months when measured colorimetrically. However at 10 months small but definite differences showed in amount of extracted pigment.

Judges scores after 10 months' storage were as follows: color 8.7 (range 7.0-9.8), flavor 7.5 (range 5.8-8.5), odor 7.4 (range 5.0-8.9), texture 7.9 (range 6.8-9.3). Evidently there is little deterioration in frozen shrimp after 10 months' storage if they are packed under the conditions of these experiments. The scores are much higher than those obtained in the first group of experiments after comparable storage periods.

Scores on smoked shrimp after 10 months' storage were slightly higher (except for color) than the average for all other shrimp (color, 8.1; flavor, 9.0; odor, 8.8; texture, 9.4). These values indicate the acceptability of the smoke flavored product.

The loss of pigment calculated from colorimetric data for all precooked frozen shrimp after ten months' storage is given in Table 3. The protective effect of ascorbic acid is indicated by the low percentage of pigment loss as compared to the control for that sample. BHA and liquid smoke also exerted a protective effect, and there was a synergistic action between smoke and ascorbic acid. There was no pro-oxidant effect of salt demonstrated in these experiments.

Judges did not detect appreciable differences between precooked and raw frozen shrimp after ten months' storage. After twelve months, however, the flavor, odor, and texture of the raw frozen shrimp were preferred. When number of preferences for single factors is considered, only in the case of odor is the preference

TABLE 1

Effect of ascorbic acid on palatability scores of frozen precooked shrimp

Storage period	No. of experiments	Color		Flavor		Odor		Texture	
		Control	Ascorbic acid[1]	Control	Ascorbic acid	Control	Ascorbic acid	Control	Ascorbic acid
2¼-4 months	4	7.4	7.7	6.7	7.2	6.3	6.9	7.6	7.8
6-12 months	5	6.2	7.9	3.1	6.8	4.3	6.8	6.2	6.6
18-19 months	3	3.7	7.9	3.6	6.4	3.7	6.6	4.9	5.8

[1] Concentration of ascorbic acid was 0.1%.

TABLE 2

Effect of precooking frozen shrimp on palatability scores

Storage period	No. of experiments	Color		Flavor		Odor		Texture	
		Frozen raw	Pre-cooked	Frozen raw	Pre-cooked	Frozen raw	Pre-cooked	Frozen raw	Pre-cooked
3 months	3	5.6	7.4	5.3	5.9	5.8	6.0	6.9	6.9
12-20 months	3	8.0	4.8	7.7	3.8	7.8	3.9	7.9	4.9

TABLE 3

Loss of pigment after ten months in frozen shrimp treated with various agents

Experiment number	Treatment	% Loss of pigment
1	Control	20.4
	Ascorbic Acid[1]	4.6
2	Control	36.3
	Ascorbic Acid	25.1
3	Control	25.9
	Ascorbic Acid	1.4
	NaCl (2%)	18.6
	Ascorbic Acid and NaCl	2.6
4	Control	23.8
	Ascorbic Acid	2.7
	BHA (.02%)	16.2
5	Control	40.7
	Ascorbic Acid	26.0
	Smoke (.15%)	24.8
	Ascorbic Acid and Smoke	0.0

[1] Concentration of Ascorbic Acid was 0.1% in all experiments.

significant. However, when the number of preferences for all factors is considered as a whole, the preference for the raw frozen shrimp is significant.

When ascorbic acid treated raw frozen shrimp (0.5% dip for 2 minutes) were compared with ascorbic acid treated precooked shrimp the preference for the precooked sample (all factors considered) is significant after ten months' storage. However, after twelve months' storage, the preference is highly significant for the sample cooked after freezer storage.

Comparison of findings on raw frozen shrimp with and without ascorbic acid treatment shows some evidence of protection by the agent. Color, flavor, and odor scores for the ascorbic acid treated sample were slightly higher after twelve months' storage. Colorimetric readings also indicated slight protection against oxidative changes by the ascorbic acid dip. Judges scores showed no differences in texture of the 2 samples. Possibly a longer dipping time or a more concentrated solution of the ascorbic acid would show greater inhibition of oxidative changes.

The results of the two groups of experiments demonstrate the adverse effect of poor storage conditions. It is not possible to say at this time whether the poorer quality of frozen shrimp in the initial experiments was due to the difference in freshness of material, different packaging, or higher storage temperature. Experiments are under way to test the effect of different packaging materials.

In the later experiments, the scores of all shrimp after 10 months' storage indicate that a high quality pre-cooked frozen shrimp product is possible even without the use of anti-oxidants or texture-preserving treatments. Further checks on all experimental variations after longer storage periods are planned in order to determine whether it is feasible to hold pre-cooked frozen shrimp for longer than 10 months.

The fact that colorimetric differences were obtained after 10 months' storage and organoleptic differences were not evident at that time indicates that the colorimetric method is more sensitive for detection of early deteriorative changes.

SUMMARY

Under adverse storage conditions, pre-cooked frozen shrimp show deteriorative changes in color, flavor, and odor after three months and texture changes after six to twelve months. Under optimum storage conditions, pre-cooked frozen shrimp show little deterioration after storage periods of up to ten months.

Color, odor, and flavor loss in stored frozen shrimp are probably related oxidative changes, and the colorimetric measurement of fading offers a quantitative means of determining degree of deterioration. Oxidative changes can be inhibited by the use of ascorbic acid, BHA, or liquid smoke flavoring. Ascorbic acid and liquid smoke act synergistically in inhibiting oxidative changes.

"Smoked" shrimp prepared by addition of liquid smoke flavoring to the cooking water are an acceptable product.

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Highlights on Newly Developed Flavoring Aromatics[a]

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Proper nomenclature, chemical and physical properties of organic preparations used in flavorings are stressed. Some naturally occurring aromatics are given and uses cited. Some newly discovered completely synthetic aromatics are discussed and found to be of use in flavors.

Newly discovered aromatics employed in the flavoring industry are not widely publicized as they are considered more or less as trade secrets. It is our desire to acquaint food chemists and technologists with recent developments in aromatics which have produced new flavor effects and have improved the taste and aroma of the finished food product. The old-time esters and ethers employed in the flavoring industry for the past eighty years have taken a downward trend as a result of the successful search for finer taste and aroma in the manufacture of food products.

NOMENCLATURE ASPECTS

Some organic preparations used in the flavoring industries are not sold under their true nomenclature, thereby depriving the chemist of the information necessary to formulate his product. It is very important to know the true chemical composition of a product both from the standpoint of compatibility and the need to meet labeling requirements. Quite often information given on aromatic chemicals is misleading. Most of the fine aromatics are sold under trade names and, although chemical and physical data are partially given, the true chemical identity is not often revealed. It should be the aim of organic chemists not only to find new and finer aromatics but also to market them under their proper nomenclature, giving information as to the chemical and physical properties, as well as on the utilization of such aromatics.

The aldehydes. So-called aldehydes such as C-14, C-16, C-18, etc. do not actually represent true products made from their corresponding alcohols or acids. These are misnomers for such chemicals as gamma undeca lactone, methyl phenyl glycidate of ethyl and gamma nonyl lactone. The reason that these facts are mentioned here is that lactones and glycidates will react much more favorably with other components in flavoring products than will aldehydes. If chemists accept the lactones and glycidates as aldehydes, they will have to exercise caution and not use certain materials in their formulations that might lead to polymerization. In other words, they are running the risk of depriving a given compound of an essential aromatic which might be fully compatible with lactones or glycidates.

There is need to beware of some aromatics. Certain of these have been analyzed and found to be *simulated* aromatics under chemical names. Examination of so-called cinnamyl anthranilate, which is supposed to be an anthranillic acid ester of cinnamic alcohol, showed it to be a mixture of methyl anthranilate and other esters. Synthesized cinnamyl anthranilate yields a crystalline material of grapey character and of high fixative value. Cinnamyl anthranilate can be used in many formulations in products like grape, apple, peach, apricot, etc.

Such aromatics as simulated vanilloin (dihydro?) and simulated vanillic ester not made from alcohols and corresponding acids are not to be recommended. They usually are mislabeled as derivatives of protocatechuic aldehyde of which methyl and ethyl products are made; they are known under the names vanillin and ethyl vanillin.

The importance to the flavoring chemist of selecting pure chemical products under true names, with complete data on the physical and chemical properties of the aromatics in question, can scarcely be overemphasized.

It has long been the goal of a great many organic chemists to synthesize not only aromatics found in essential oils but also those found in fruits, vegetables, etc. One of these aromatics is methyl beta methyl thiolpropionate, *(7)* commonly known as pineapple mercaptan. This aromatic was successfully tried in 0.05% concentration, together with other ingredients used in pineapple flavoring, to the entire satisfaction of flavoring chemists.

Synthetics. In addition to the chemical bodies found in natural products, many modifications in flavor and aroma have been worked out by synthesizing materials not known to be present in natural products. Two such synthetic products, allyl phenoxy acetate and allyl cyclohexane propionate, are now available. Other products that are worthwhile to use in pineapple, apple, and banana blends are ethyl and allyl hexadienoate.

Other synthetics isolated from natural essences and now being used in fruit flavors with good results are shown in Table 1.

Among newly developed aromatics it is important to mention diallyl sulfide and allyl mercaptan. Both products possess the aroma and taste of natural garlic and onion oils. These products are manufactured by our company in their pure state.

Of polyfunctional ketones, which are utilized by many manufacturers to produce such effects as maple, butterscotch, and in some cases strawberry, raspberry, etc., one that merits particular attention is methyl cyclo pentenolone. This very interesting aromatic has a distinct taste of maple and in combination with natural butter flavorings, produces a delicious butterscotch

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TABLE 1
Some synthetics now in use, the aromatics employed, and typical formula

Natural flavor	*Aromatic isolated*	*Sample formula*	%
Raspberry	Beta ionone *(2)*	Beta ionone	10
	Anisic aldehyde *(5)*	iso-butyl acetate	23.49
	Benzaldehyde *(3)*	Anisic aldehyde	1
	Phenyl ethyl alcohol *(3)*	Phenyl ethyl alcohol	3
		Phenyl ethyl iso-butyrate	4
	Hexene *(1)*	Ethyl methyl p-tolyl glycidate	35
	n-hexanol	Phenyl ethyl anthranilate	7
	iso-amyl alcohol *(1)*	Vanillin	3
	iso-butyl alcohol *(1)*	Hexyl butyrate	0.5
		iso-amyl acetate	4
		Ethyl n-butyrate	5
		Rose oil	4
		Diallyl sulfide	0.01
Strawberry	Borneol *(4)*	Ethyl methyl phenyl glycidate	35
	Methyl caproate *(4)*	Amyl aldehyde	0.5
	Amyl aldehyde *(4)*	Bornyl acetate	0.5
	Ethyl Caproate *(4)*	Ethyl caproate	2
		Vanillin	3
		Beta ionone	9
		Ethyl methyl p-tolyl glycidate	12
		iso-butyl acetate	30
		Ethyl butyrate	8
Cherry	Geranyl butyrate *(15)*	Cinnamyl anthranilate	3
	Ethyl caprate *(15)*	iso-amyl acetate	12
	Terpenyl butyrate *(15)*	iso-butyl acetate	12
		Cinnamic aldehyde dimethyl acetal	3
	Ethyl caproate *(15)*	Benzyl alcohol	7.5
	Benzaldehyde *(11)*	Geranyl butyrate	2
	Geraniol *(11)*	Ethyl caprate	4
		Terpenyl butyrate	0.5
		Ethyl caproate	2
		Benzaldehyde	8
		p-tolyl aldehyde	3
		p-methyl benzyl acetate	11
		Ethyl methyl p-tolyl glycidate	16
		Vanillin	7
		Heliotropin	5
Peach	Linalyl esters *(14)* (as valerate,acetate, formate)	Linalyl formate	10
		Gamma undeca lactone	13
		linalyl butyrate	4
	Furfural *(14)*	Heliotropin	14.5
		Geranyl valerate	15
		Furfural	1.5
		alpha-methyl furyl acrolein	6
		Methyl cyclo pentenolone valerate	10
		Benzaldehyde	5
		iso-amyl formate	15
		iso-butyl butyrate	6
Apple	Geraniol *(13)*	Geranyl valerate	10
	Acetaldehyde *(12, 16)*	Geranyl n-butyrate	8
		Geranyl propionate	8
		Linalyl formate	10
		iso-amyl valerate	15
		Vanillin	8
		Allyl caprylate	6
		Geranyl aldehyde (citral)	5
		Acetaldehyde	6.5
		Methyl cyclo pentenolone valerate	8
		alpha methyl furyl acrolein	2
		iso-amyl butyrate	13.5
Coffee	a-furfuryl mercaptan	a-furfuryl mercaptan	10
		ethyl vanillin	3
		solvent	87

flavor. Methyl cyclo pentenolone, having a ketone and alcohol group, can be esterified with various acids. The acetic, butyric and propionic acid esters have been produced. In this case the OH in the ring was substituted by corresponding acid and very good results were obtained. For example, methyl cyclo pentenolone acetate, butyrate, propionate and valerate can be utilized to produce desirable results in walnut, pistachio, and hazelnut flavorings, while the valerate and propionate can be used in apple and black currant flavors.

Several unsaturated ketones are being utilized in the flavoring industry although the work is yet in the experimental stage. Ketones such as vanillidene and piperonal (acetone), made by aldo condensation reaction, certainly deserve consideration in the flavoring field.

Alpha irone, which is unbelievably good as one of the aromatics for use in raspberry and strawberry flavors, shotfld be studied fully as substitutes for such ketones as methyl, alpha and beta ionones which are used in the production of fruit flavorings. Methoxy phenyl pentenone (d-methyl anisal acetone) is a crystalline product. Minute quantities of this ketone can be used in maple and also in such flavors as currant, raspberry, strawberry and honey. It blends well with methyl cyclo pentenolone or its esters in butterscotch and nut-like flavors. Both are products of good stability.

Last, but not the least interesting of these bodies, is maltol, a crystalline material which can be utilized in the same products as methoxy phenyl pentenone. In making butterscotch, as mentioned before, the addition of concentrated butter flavoring produced from pure butter is noteworthy. These butter derivatives and butter esters are effective enhancers of flavor. The latter have a definite creamy butter taste and aroma.

Many of the synthesized products listed in this paper are worthwhile additions to the group of aromatics used in the flavoring industry. However, they require careful investigation and establishment of compatibility with other aromatics. Such information is available from the producers of such products.

It is necessary on many of the new, as well as the old, aromatics to establish toxicological tolerance in food products. Various trade associations and institutions are constantly working on such data. It is generally accepted in the trade that when aromatics are used in suggested proportions they are not deleterious.

The allergic effect on some individuals using certain of these aromatics merits comment. Many products of extreme strength should certainly be used cautiously and in diluted form. For the convenience of compounders, concentrated solutions of such products may be obtained from manufacturers.

An investigation has been conducted on the dermal irritation properties of some aromatics and essential oils *(10)*. Reprints of this report are available.

Furfural acetone and a line of related compounds were tested by the Stanford University Medical School on Erlich Ascites Tumor as a possible tool in cancer research *(6)*. Many of the compounds, produced for this purpose, have a pleasant taste and aroma of cinnamon, clove and general spice.

Only the most important of the newly developed aromatics have been discussed here. These products have found universal acceptance in the flavoring industry. Due to the availability of raw materials, great progress has been possible.

IMPORTANT NEW AROMATICS

Physical and chemical constants of the products listed below (Table 2) were determined in our laboratories.

Comments on the organoleptic and olfactory characteristics and recommended dosage to be used in finished products were also derived from the experience of our laboratories.

TABLE 2
Checklist of newly developed aromatics

Aromatic	Boiling point—°C.	Refractive index	Aromatic character
Allyl anthranilate*	104-106@1	1.5720@24	leafy, winey
Allyl n-butyrate*	80@70	1,4176@15.5	apple and pit
Allyl cinnamate*	105-108@1	1.5661@23	pit flavor
Allyl cyclohexane acetate	66@1	1.4574@20	pineapple, banana
Allyl cyclohexane butyrate	104@1	1.4574@20.5	pineapple, butter
Allyl cyclohexane caproate	128@1.5	1.4620@21	grape, brandy
Allyl cyclohexane propionate	91@1	1.4595@22	pineapple, strawberry
Allyl cyclohexane valerate	119@1	1.4605@22	peach, apricot, apple
Allyl 2-ethylbutyate*	58-60@6	1.4240@15	fruit pit
Allyl furoate*	84-88@6	1.4960@19	sharp mushroom note
Allyl hexadienoate*	67-68@1	1.5066@24	pineapple, anise, melon
Allyl mercaptan*	67-68	1.470	garlic
Allyl pelargonate	87-91@3	1.4332@20.5	pineapple, brandy
Anisyl n-butyrate	110-113@1	1.5020@24	pit and vanilla
Anisyl propionate	100-103@0.5	1.5112@15	pit, quince, vanilla
Cinnamyl anthranilate	m.p. 63-64°		distinctive grape
Cyclohexanethyl acetate*	58-60@0.5	1.4476@21.5	pit, raspberry
Cyclohexyl acetate	61-62@12	1.4390@26	apple, banana
Cyclohexyl n-butyrate	68-71@2	1.4489@17	banana, currant, apple
Cyclohexyl caproate	89-91@2.5	1.4465@17	pineapple, banana, brandy
Cyclohexyl cinnamate	139-143@1	1.5646@15	peach, cherry
Decyl n-butyrate	111-114@2	1.4300@23	brandy, citrus
Diallyl sulfide*	139	1.4877@27	garlic, onion constituent
2-ethylbutyl acetate	55-57@9	1.4100@23	pear, gooseberry
Alpha ethyl furyl acrolein	73-77@0.5		cinnamon, cola
Ethyl hexadienoate*	58-60@2	1.4940@22	pineapple, melon, gooseberry
Ethyl methyl p-tolyl glycidate	121-128@3	1.5085@21	distinct strawberry
Furfuralacetone*	86-88@2	m.p. 37-38°	cinnamon, clove
Alpha furfuryl mercaptan	55-57@17	1.531@25	constituent of coffee
Methyl cyclo pentenolone	m.p. 105-107°		maple, vanilla, butterscotch
3-hydroxy 2-methyl 4-pyrone (maltol)*	m.p.160-163°		strawberry, raspberry, fruit
Alpha irone*	110-112@3	1.4970@20	orris root
Menthadiene-7-carbinol*	98-110@2	1.5047-70@15	lime, spice
Menthadiene-7-carbinyl acetate*	98-111@1	1.4820@22	lime, spice
Methoxy phenyl pentenone (alpha methyl anisal acetone)*	m.p. 60-62°		butter, butterscotch, cherry
Alpha methyl furyl acrolein*	85-90@1.5		cinnamon, cola, clove, mace
Methyl beta methyl thiolpropionate*	77-83@14	1.4656@18	occurs naturally in pineapple
Methyl furoate*	81-82@20		mushroom, meaty
Gamma octalactone	83-86@1	1.4610@15	cocoanut, peach
Piperonal acetone	m.p. 109-110°		heliotrope, vanilla, cherry
Gamma stearolactone	m.p. 47°		cocoanut, cheese, butter
iso-valerophenone*	77-79@1	1.5147@15.5	nut, spice
Vanillidene acetone	m.p. 128-129°		vanilla, butterscotch

*The asterisk indicates that the substance is used less than 1 part per million in finished product. All others are used more than 1 but less than 25 parts per million in finished food.

CONCLUSION

Selecting aromatics to be incorporated in the formulation of a flavor is a matter of personal experience and taste. All we have attempted to do here is to give general guidance for the utilization of newer aromatics. Following the formulae, or any other information given to the compounder, does not always produce satisfactory results. The chemist working with aromatics must be well qualified. Olfactory and organoleptic training is essential and this can be attained only by experience.

Knowing the facts about aromatics helps a great deal in creating new formulae. There is a great deal of similarity between taste, aroma, odor—and even music. In compounding flavorings, musical theory could be applied. Proper compounding produces harmony; improper compounding will produce a discord; in short, "sharps" and "flats" can be observed in compounding flavors as well as in composing music. Qualitatively, some of the sharp notes in compounding flavors can be attributed to such aromatics as highly volatile esters, aldehydes, mercaptans, and low carbon organic acids.

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Volatile Reducing Substances in Canned Bartlett Pears[a]

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The influence of ripeness of fresh Bartlett pears on flavor and on the quantity of various volatile reducing substances in the canned product was investigated. As pears ripened at 68° F. (20° C.), methyl alcohol, total carbonyl compounds, acetyl methyl carbinol, diacetyl, and ester content gradually increased. The rate of production of such compounds was especially rapid when the pressure test of the fresh pears dropped below 2 pounds. The presence of an excess of methyl alcohol and diacetyl might be used as a criterion of off-flavor and overripeness. The presence of excess methyl alcohol in overripe Bartlett pears was thought to be caused by de-esterification of the methyl ester group of the pectin molecule by the enzyme pectin-esterase. The importance of these constituents to flavor of canned pears is discussed.

In a previous study it was reported that ripeness of fresh Bartlett pears as measured by pressure test is related to flavor acceptance of the canned product *(19)*. Fresh Bartlett pears with an average pressure test of 2 to 3 pounds produced the highest quality canned product. There was also a correlation between the ripeness of fresh pears, as measured by pressure test, and the amount of volatile reducing substances (VRS) in the canned product. Canned Bartlett pears with high VRS content were scored high in flavor and aroma. The presence of acetaldehyde in pears has been reported *(21)*. Tindale, Trout, and Huelin *(25)* found an increase in alcohol and acetaldehyde content during ripening of Bartlett pears at 65° F. (18° C.). Ezell and Diehl *(7)* reported on the relation of maturity and handling of Bartlett pears grown in the Pacific Northwest to quality of the canned product but gave no information on the volatile substances. The chemistry of fruit and vegetable flavors has been reviewed by Kirchner *(14)*, but information on flavor constituents of pears is very scarce.

In the study reported here, some of the volatile compounds in canned Bartlett pears that bear a close relationship with the pressure test of the fresh fruit and the flavor and aroma score of the canned product are identified. Thus, it may be possible to develop chemical tests that will supplement or possibly replace subjective organoleptic methods used in quality evaluation of canned Bartlett pears. Likewise, the effects of climatic conditions, cultural practices, and processing variables on the quality of canned Bartlett pears may be investigated more objectively.

MATERIALS AND METHODS

Bartlett pears. The pears used in this investigation were harvested on September 2, 1953, from the Homer Henderson Orchard, Lake County, California. Immediately after harvest, 2 tons of pears were hauled to Davis and stored at 32° F. (0° C.). The firmness of the fresh pears at harvest was 16 to 18 pounds, and the soluble solids content as measured by a refractometer was 11.12 ± 0.51% at 68° F. (20° C.) *(19)*. The pears were kept at 32° F. (0° C.) for 7 days and then ripened in a 68° F. (20° C.) room at 85% relative humidity until they reached the desired firmness. It takes about 4 to 5 days at 68° F. (20° C.) for pears to reach canning ripeness. Pears of desired firmness were taken out periodically for canning and chemical analyses.

Canning. Bartlett pears of proper pressure tests were peeled and cored in a Food Machinery and Chemical Corporation pear-peeler and then dipped into tap water for 3 to 5 minutes. The pear halves were trimmed and sorted before canning. Eighteen ounces (± 0.05 oz.) of pears and 11 ounces of 25° Brix sucrose syrup were placed in each No. 2½ can. All cans were sealed under 15 inches of vacuum and cooked for 30 minutes at 212° F. (100° C.) in a rotary cooker. The processed cans were cooled rapidly in a rotary cooler and then stored at room temperature.

Flavor evaluation. Three months after canning, a panel of 15 selected persons evaluated the pears for flavor, using a balanced incomplete block design method as described in a previous paper *(18)*. An aliquot of each sample was used for chemical analyses.

Pectin-esterase activity. The enzyme pectin-esterase was extracted from pears of 2 to 3 pounds firmness, which had been previously frozen at 0° F. (−17.7° C.). The frozen pears were thawed and mixed with an equal weight of 10% sodium chloride solution at pH 7.0. The pectin-esterase activity in the extract was determined by measuring the rate of liberation of carboxyl groups in a 0.5% solution of pectin N. F. at pH 7.5 and a temperature of 84.9° F. (29.4° C.) *(12)*. One unit of pectin-esterase activity (PEU) is the amount that releases 1 milliequivalent of acid per minute.

Physical and chemical tests. The tests for pressure reading, pH, soluble solids, total titratable acids, and ascorbic acid in the pears were the same as those described in a previous paper *(19)*. For canned pears, syrup and fruit were blended together in a Waring blender for 30 seconds prior to chemical analyses.

Reducing sugars. The content of reducing sugars was determined by an alkaline-ferricyanide method modified by Hassid *(9)*. The results were reported as dextrose equivalents.

Volatile reducing substances (VRS). The amount of VRS in canned pears was determined by steam distilling 200 g. of the sample in an all-glass apparatus. The sample was obtained by mixing the juice and pears from 3 cans of chilled pears in a Waring blender for 30 seconds. The distillate was collected through an ice-water-circulated spiral condenser directly into an ice-cooled receiver. Any uncondensed volatile compounds were sucked through a sintered glass tube into a receiver containing 20 ml. of distilled water, which was also chilled in an ice-water bath. Distillation was stopped after about 170 ml. of the distillate had been collected, which required about 30 minutes. The distillation was done under a slight negative pressure created by a water aspirator. The contents were diluted to 200 ml. with distilled water, and 75-ml. aliquots in duplicate were used for determination of total VRS as described in a previous paper *(18)*. The remainder of the sample was used for analyses of methyl alcohol, total carbonyl compounds, acetyl-methyl-carbinol, and diacetyl.

Methyl alcohol. A 2-ml. aliquot of the 200-ml. distillate was used for the determination of methyl alcohol by permanganate oxidation and chromotropic acid reagent as described by Boos *(4)*.

Total carbonyl compounds. A 1-ml. aliquot of the distillate was analyzed for total carbonyl compounds by measuring the color developed with 2,4-dinitrophenylhydrazine in alkaline solution at 480 mμ in a Beckman Model DU spectrophotometer as described by Lappin and Clark *(17)*.

[a] Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 15, 1955.

Voges-Proskauer reaction. Twenty-ml. aliquots of the distillate were analyzed for acetyl-methyl-carbinol and diacetyl content by the Voges-Proskauer reaction *(2)* as described by Byer *(5)*. In each analysis 5 ml. of 5% alpha-naphthol in 99% isopropyl alcohol was used instead of 10 ml.

Determination of esters. Ester content of the canned pears was determined essentially by the colorimetric method originated by Hill *(10, 11)* and used by Thompson *(24)* for esters in apples. This method is based on the conversion of the esters to hydroxamic acid, which forms red complexes with ferric ion. The method was slightly modified as follows: 2 cans of Bartlett pears were first chilled in an ice-water bath. The pears and syrup were then mixed in a Waring blender for 30 seconds. A 250-g sample of slurry was weighed into a 600-ml. beaker, and 100 ml. of distilled water was added. The mixture was brought to pH 7.5 with N NaOH while being stirred vigorously. A Coleman pH meter was used to determine the end point. Twenty-five ml. of freshly prepared 5% mercuric acetate solution in water was added to precipitate tannins and other interfering substances. The resulting mixture was readjusted to pH 7.5 with N NaOH to convert the organic acids into anions, and then diluted with distilled water to 500 ml. in a volumetric flask. The solution was mixed well and centrifuged. About 330 ml. of the supernatant was accurately measured and quantitatively transferred into a Köttsdorfer-type ether extractor for liquids *(13)* with 70 ml. of distilled water. The solution was extracted with 250 ml. of reagent grade ethyl ether for 24 hours. A 5-ml. portion of the ether extract was pipetted into a 25-ml. graduated cylinder with glass stopper. To this was added 1.5 ml. of a freshly prepared and centrifuged solution of hydroxylamine, made by mixing equal volumes of 5% hydroxylamine hydrochloride and 12.5% sodium hydroxide in methanol. The mixture was allowed to stand at 77° F. (25° C.) for 30 minutes, and 12.5 ml. of ferric perchlorate reagent solution was added. The ferric perchlorate reagent solution was made by mixing 2 ml. of stock ferric perchlorate solution (1.93 g. $FeCl_3 \cdot 6H_2O$, 5 ml. conc. HCl, and 5 ml. 70% perchloric acid diluted to 100 ml. with water) with 7.5 ml. of 70% perchloric acid, and then diluting to 100 ml. with ethanol. The solution was mixed thoroughly and allowed to stand for 10 minutes. The color was measured in a Klett photocolorimeter, using a 540 mμ filter. A blank was prepared using all the reagents and 5 ml. of reagent grade ethyl ether instead of the ether extract. A standard curve was constructed in the same manner as above, using redistilled reagent grade ethyl acetate.

Identification of acetaldehyde. Because of their higher VRS content, pears canned at 1.2 pounds pressure test in 25° Brix sucrose syrup were used to identify acetaldehyde. Three successive batches of 200 g. pear pulp each were steam distilled into the same ice-cooled receiver for 30 minutes. The total amount of distillate from 600 g. pear pulp was about 170 ml.

The 2,4-dinitrophenylhydrazone was prepared according to the method described by Lappin and Clark *(17)*. Sixty ml. of saturated solution of twice recrystallized 2,4-dinitrophenylhydrazine in carbonyl-free methanol and 12 ml. of conc. HCl were added to the distillate. The flask containing the reaction mixture was loosely stoppered and heated in a water bath at 118.4° F. (48° C.) for 30 minutes. The phenylhydrazone was extracted with 150 ml. of ethyl ether and separated from the reaction mixture in a separatory funnel. The ether was evaporated in a current of air at room temperature. The residue containing the derivative was dried overnight in a vacuum oven at 82.4° F. (28° C.) and finally in a desiccator containing $CaCl_2$. The dried residue containing the derivative and excess reagent was dissolved in a mixture of 1 part benzene and 2 parts petroleum ether. The solution was poured into a 19 mm. x 80 mm. column packed dry with 2 parts of Merck reagent grade silicic acid and 1 part by weight of Super-cel. The column was eluted with petroleum ether containing 4% ethyl ether. A large and strong yellowish-orange colored band (fraction 1) moved down with this solvent followed by another yellow band (fraction 2). The whole column was extruded, and the yellow bands were cut and extracted separately with methanol. After filtration by suction, the solvents were evaporated in a current of air. Fraction 1 was dissolved in 25 ml. of hot ethyl alcohol, and then about 5 ml. of water was added until the mixture became turbid. After 12 hours at room temperature, the crystals were filtered and recrystallized twice by the same procedure. The crystals were separated and dried in a vacuum oven at 131° F. (55° C.) and finally in a $CaCl_2$ desiccator overnight.

Paper chromatography. The 2,4-dinitrophenylhydrazone of acetaldehyde prepared from the pear distillate was also identified by comparing its Rf value with that from a known sample by paper chromatography on Whatman No. 1 filter paper using the epiphase of heptane-methanol as developing agent *(22)*.

RESULTS

Chemical analyses and flavor score of canned Bartlett pears. Pears canned at different stages of ripeness, as judged by pressure tests, were canned in 25° Brix sucrose syrup and then stored at room temperature for 3 months to allow exchange of constituents between fruit and syrup. The canned fruits were then evaluated for quality both by chemical analyses and flavor scoring (taste tests). The results are shown in Table 1. The soluble solids and sugar contents of the samples differed very little. Thus any difference in flavor was not due to sweetness. Riper pears had lower ascorbic acid content. Flavor scores of the canned pears increased with a decrease in pressure test of the fresh fruit. Samples canned at 1.5 pounds pressure test scored highest in flavor. The results agree in general with a previous report on Bartlett pears *(19)*, even though the fruits were grown at two different districts in different years.

Volatile reducing substances. Results (Table 2) indicate that the total VRS of canned pears increased with a decrease in firmness of the fresh fruit. The amount of total VRS correlated well with the flavor score of the canned product down to a firmness of 1.5 pounds in this test. A coefficient of correlation of 0.90, significant at a probability level of 2%, was found. Below 1.5 pounds there was a reduction in flavor score, although VRS continued to increase. This would indicate that qualitative as well as quantitative determinations of VRS are important in evaluating flavor acceptance.

The amounts of various types of VRS in Bartlett pears canned at different stages of ripeness are shown in Table 2.

TABLE 1

Chemical analysis and flavor score of canned Bartlett pears of different stages of ripeness

Sample	Texture of fresh pears prior to canning in lbs.	pH	Soluble solids in ° Brix at 20° C.	Total titratable acids as % citric monohydrate	Ascorbic acid in mg./100 g.	Sugars		Average flavor score [1, 2]
						Before inversion, as % Dextrose	After inversion, as % Dextrose	
A	3.8 ± 0.3	4.00 ± .06	18.46 ± 0.23	.301 ± .014	1.69 ± .14	6.53	16.33	4.98
B	3.4 ± 0.4	4.03 ± .04	18.31 ± 0.31	.291 ± .018	1.69 ± .16	6.96	16.75	5.85
C	3.2 ± 0.3	4.06 ± .08	18.24 ± 0.29	.276 ± .026	1.30 ± .17	6.22	16.52	6.83
D	2.4 ± 0.3	4.05 ± .06	18.32 ± 0.31	.281 ± .024	1.51 ± .15	6.48	17.10	6.80
E	1.9 ± 0.2	4.02 ± .06	18.21 ± 0.14	.302 ± .012	1.53 ± .15	6.50	16.09	6.92
F	1.3 ± 0.3	3.99 ± .06	18.34 ± 0.21	.286 ± .028	1.28 ± .13	6.52	16.58	8.35
G	1.2 ± 0.4	4.06 ± .05	18.34 ± 0.16	.290 ± .018	1.24 ± .08	6.22	16.40	7.90

[1] Samples are scored for flavor by balanced incomplete block design method by a panel of 15 people. A scale of 1 to 10 was used. An excellent sample was scored 9 to 10 points: good, 7 to 8; fair, 5 to 6; poor, 3 to 4; and very poor, 1 to 2.

[2] Differences in flavor score between samples C:D, C:E, D:E and F:G are not significant at 2% level. The rest of the combinations are significant to 2% level or better.

TABLE 2

Volatile reducing substances in canned Bartlett pears (juice and pears combined)

Pressure test of fresh pears in lbs. (5/16" plunger)	Total volatile reducing substances as microeq. $KMnO_4$/ 50 g.	Total carbonyl compounds as acetaldehyde mg. per kg.	Methyl alcohol mg. per kg.	Acetyl methyl carbinol by Voges-Proskauer reaction mg.per kg.	Diacetyl mg. per kg.	Esters micro-moles per 100 g.
14.4 ± 1.0	99.7	2.6	6.5	0.2	0	6.5
5.5 ± 0.5	147.0	3.8	8.4	0.5	0	6.0
3.8 ± 0.3	157.0	5.0	9.4	0.6	0	6.6
3.4 ± 0.4	140.0	4.0	10.5	0.7	0	7.2
3.2 ± 0.3	165.8	5.7	12.5	1.5	0	7.9
2.4 ± 0.3	195.0	6.0	13.3	1.3	0	8.9
1.9 ± 0.2	288.0	4.6	23.8	1.1	0	19.3
1.5 ± 0.3	356.0	10.4	40.0	6.2	1.6	21.1
1.2 ± 0.4	377.0	12.4	96.0	7.4	6.2	24.9

The methyl alcohol content increased with a decrease in pressure test of the fresh pears. It increased very rapidly as the pressure test dropped to 2 pounds or less. The coefficient of correlation was —0.74, significant at a probability level of 5%. The amount of carbonyl compounds increased as the pressure test decreased with a coefficient of correlation of —0.78, significant at a probability level of 5%. Ester content increased as the firmness decreased. The rate of increase in ester content was most rapid as the pressure test dropped below 2.4 pounds. Since the flavor of the canned product scored highest if the fresh pears tested 1.5 pounds, it might be inferred that the rapid increase in methyl alcohol, acetyl-methyl-carbinol, and carbonyl compounds has a certain optimum range. When these compounds are present in excessive amounts, off-flavor may result. It might also be possible that at 1.5 pounds, these volatile compounds are not at levels injurious to eating quality, and the improvement in flavor was caused by other aromatic compounds which were not investigated in this work.

Diacetyl, which may be an undesirable constituent, began to show up as the firmness of the fresh pears dropped to 1.5 pounds. It is important to point out that the various VRS did not increase at the same rates as the firmness decreased, although they all increased during ripening. Apparently they accumulated as end products of various metabolic processes. Although the presence of diacetyl was demonstrated by the Voges-Proskauer reaction, further work is needed to identify the compound chemically.

Identification of acetaldehyde. Acetaldehyde was identified in the steam distillate from pears canned at 1.2 pounds pressure test as crystalline 2,4-dinitrophenylhydrazone melting at 329° F. (165° C.). When the derivative was mixed with that of known acetaldehyde, no drop in melting point was observed. The 2,4-dinitrophenylhydrazone was also identified by paper chromatography by comparing its Rf value with that prepared from acetaldehyde, using heptane-methanol as irrigating agent in the descending direction *(22)* on Whatman No. 1 filter paper. Both samples have an Rf value of 0.21 at 71° F. (21.7° C.).

Pectin-esterase activity in Bartlett pears. Since methyl alcohol content increases during ripening of Bartlett pears, one can assume that the enzyme pectin-esterase might have de-esterified the pectin in pears to form methyl alcohol and pectic acid. It was therefore decided to demonstrate the presence of pectin-esterase in pears and to extract the enzyme for quantitative study. Results indicate that pears at a pressure test of 2 to 3 pounds have an activity of 8.4×10^{-4} pectin-esterase units (PEU) per g. of pear tissue, whereas green pears at 14 pounds pressure test have only 4.2×10^{-4} per g. of tissue. Thus it might be postulated that ripening of Bartlett pears is accompanied by de-methylation of the ester groups in the pectin molecule by pectin-esterase. This enzymic action caused the formation of a large amount of methyl alcohol, with simultaneous formation of pectic acid or lower oligouronic acids through the action of polygalacturonase *(26, 27)*.

DISCUSSION

One of the main observations that may be made on the above data is that the determination of the VRS content may be useful in evaluating quality of canned Bartlett pears. By this procedure a quantitative measure of the changes in VRS during ripening might be obtained. Once the range of volatile constituents for normal samples has been established and correlated with quality, it may be possible to objectively evaluate unknown samples for quality. The data presented here are of a rather cursory nature. However, they serve to illustrate that the quantity of VRS in Bartlett pears varies greatly with the ripeness of the fresh fruit before processing. A large amount of total VRS composed of an excess of certain volatile constituents, such as alcohols, acetyl-methyl-carbinol, carbonyl compounds and others, might be used as criteria of overripeness and off-flavor. In the past, the majority of the work on volatile constituents of fruits has been on only one particular stage of ripeness of a certain fruit *(8, 15, 16, 28)*. It is advisable to investigate the same fruits at different stages of ripeness.

Only a few of the many possible VRS of Bartlett pears are reported in this paper. However, the quantities of these constituents correlated well with changes in firmness of the fresh fruit and flavor acceptance of the canned product. In this test pears canned at 1.5 pounds firmness scored highest in flavor, with off-flavors developing in softer fruit. Studies with fresh pears indicate that firmness alone is not always a reliable indication of off-flavor development. Further work is needed to determine these relationships.

Tindale, Trout, and Huelin *(25)* studied the storage, ripening, and respiration of 9 varieties of Australian pears. They indicated that during ripening of Bartlett pears at 65° F. (18.1° C.) there was a considerable and continuous increase in the alcohol content. Acetaldehyde content increased during cold storage and subsequent ripening and reached its maximum concentration at the onset of core breakdown. They postulated that this was due to the progressive replacement of normal oxidative metabolism by anaerobic respiration. The work reported on here showed similar trends although the quantities of carbonyl compounds found were lower than those of the Australian Bartlett pears. This variation could be caused by differences in climate, or cultural factors, and specificity of the methods used in analyses.

It has been reported by Kirchner *et al. (16)* that there is only a small difference in the composition of fresh and freshly canned grapefruit juices. During storage, however, there was a considerable increase in the volatile acids, methanol, and other constituents. In the work reported on here, the difference in methanol, carbonyl compounds, acetyl-methyl-carbonyl, and ester content observed among the canned pears of different ripeness was not due to storage effect, since the pears were canned and stored under the same conditions. Nevertheless, it is still possible that the volatile constituents of fresh pears may differ slightly from those of the canned product because of the heating process during canning.

The gradual increase in free methyl alcohol content during ripening possibly may be explained by the hydrolysis of pectin by the enzyme pectin-esterase. It is

not known why pectin-esterase did not act on the pectin in green pears even though it was found to be present. Probably the pectin in green pears was present as protopectin, which is not available to pectin-esterase. Another possible explanation is the presence of an inhibitor for the pectic enzyme in green pears *(26, 27)*.

Although the general trends of changes in chemical constituents during ripening as reported here were the same as those for pears from another district *(19)*, there were differences in acid contents, soluble solids, and total VRS. These might be due to differences in climate and cultural practices. It is not known whether pears grown at different localities or under different cultural practices exhibit the same relationships between firmness and the amount of various volatile reducing substances. This point needs further investigation.

Because of the importance of texture in marketability of canned Bartlett pears, it is desirable to use fresh fruit with a pressure test of 2 to 3 pounds for canning, even though pears at 1.5 pounds scored highest in flavor. Pears below 2 pounds pressure test will be too soft to maintain a desirable texture, as shown in a previous paper *(19)*.

SUMMARY

The influence of ripeness of fresh Bartlett pears on flavor and on the quantity of volatile reducing substances in the canned product has been reported. It was found that during ripening there was an increase in methyl alcohol, carbonyl compounds, acetyl-methyl-carbinol, diacetyl, and ester content. The rate of production of these volatile compounds was especially rapid as the pressure reading dropped below 2 pounds. The presence of a large excess of total volatile reducing substances, methyl alcohol and diacetyl in the canned product might be indicative of off-flavor and over-ripeness. Pears canned at an average pressure test of 1.5 pounds scored highest in flavor. Because of the importance of both texture and flavor to quality of the canned product, it is desirable to use fresh fruit at a pressure test range of 2 to 3 pounds for canning.

The presence of pectin-esterase is ripe Bartlett pears has been demonstrated. The gradual increase in methyl alcohol content as pears ripen may possibly be explained by the de-esterification of pectin by pectin-esterase. The possibility of using a chemical method to supplement or replace the organoleptic method in quality evaluation of canned Bartlett pears is discussed.

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Some Aspects of Canning Soft Drinks[a,b]

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The canning of soft drinks has created many problems necessitating considerable research and development work on the container, canning methods, and product characteristics. Various factors adversely affecting shelf life of canned soft drinks are considered. Means for overcoming some of these problems are discussed.

The canning of carbonated beverages is one of the most promising and highly technical developments of the present age of modern packaging. Although the can has been generally available for only a short time, the idea of a can for this group of products is not new.

In 1935, Continental Can Company started development work on a metal container especially designed for soft drinks. Some years later, an attempt was made to package carbonated beverages in cans, but failed because it proved impossible, with materials and techniques then known, to provide a can with adequate shelf life. Another attempt was made in 1950, and a much improved container was marketed with some success. However, material restrictions due to the Korean War and economic conditions made it difficult for cans to compete with bottles. But by 1953, circumstances had changed. Consumers were accustomed to products packaged for convenience in handling and use, price relationships were more favorable, and the acceptability of the can as a package for soft drinks was established.

Today, cans are available in adequate quantities. Technical improvements have been made in can structure, linings, and manufacturing methods and continuing research promises further progress along these lines. It is the purpose of this paper to present results of some of the development work conducted by Continental Can Company's Metal Division Research and Development laboratories in Chicago on container design, and on packing procedures and product characteristics as related to the canning of soft drinks.

Soft drink components. Carbonated beverages usually contain the following ingredients: flavoring, coloring, sweetener, acidulant, water, and carbon dioxide. In addition, they may contain a preservative, antioxidant, foaming agent, or other chemical agents dependent upon the product being produced. Any or all of these ingredients, unless properly handled, may have an adverse effect on ultimate shelf life of the canned beverage. For example, syrup tanks must be adequately cleaned and sterilized, sugar cannot be allowed to become moist or damp, and color solutions must be properly preserved to avoid introducing active spoilage agents such as yeast, mold, and bacteria into the beverage. Even under good sanitation practices, contamination can sometimes occur and for this reason carbonated beverages, whether canned or bottled, usually have a preservative, such as benzoate of soda, to inhibit the action of microorganisms.

In addition, any metallic impurities may cause the fading of color in the canned beverage and influence the flavor of the product. Water not properly treated may contain minute solid particles or other suspended matter which will result in poor retention of the carbon dioxide. Warm syrup, low gas content or pressure, and air in the carbon dioxide itself will also result in poor carbon dioxide retention and an inferior product.

But of all the ingredients, acidulants (citric, tartaric, phosphoric or lactic acids) caused the most complex problems in the early stages of canning soft drinks. Initial improvements in the metal container minimized these problems and resulted in the design and development of containers to suit particular beverage formulae which guarantee adequate shelf life and safeguard the taste and flavor of the canned carbonated beverage.

Metal Containers for Soft Drinks

A package for soft drinks must meet certain specific requirements: it must be made of materials capable of holding the product under considerable pressure and yet these materials must not affect the wholesomeness or flavor of the beverage. In addition, the container must be light in weight, sanitary, easily filled and faultlessly sealed. The metal container for soft drinks fulfills these requirements, through the judicious selection and use of can-making materials and methods.

Two types of cans are presently being used for packaging soft drinks: Cap Sealed and flat top cans. The Cap Sealed can with a cone top and crown closure is somewhat similar to the soft drink bottle; the flat top can is similar in appearance to the present flat top beer can.

The cans and ends are lined on the inside with two or more coats of can-lining materials to guard the taste, appearance, and wholesomeness of the contents. The first coat is usually applied on the flat sheet of tin plate before the can body is formed. In the case of the Cap Sealed can, the second coat is applied after the can has been fabricated. In the case of the flat top can, the second coat is applied after body manufacture but before end assembly. A decorative label is lithographed on the outside of the can by the can manufacturer and the exterior of the can and ends is further protected by one or more applications of a protective material.

Carbonated beverage cans must withstand the maximum internal pressure developed by the product during storage. To meet these requirements, the side seam and

[a] Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 12 through June 16, 1955, at the Symposium on Canning and Processing, June 13, 1955.

[b] A Monsanto Award paper, Fifteenth Annual Meeting of IFT at Columbus, Ohio.

ends must perform satisfactorily under the maximum pressure conditions anticipated. Side seams having outside soldered tabs were designed specifically for use on carbonated beverage cans, thus increasing the over-all strength of the container and preventing the seam from opening, even under critical storage conditions. The structure of the container was further improved by the development of a specially designed end unit to give it greater stiffness. In addition, in order to minimize metal exposure during the double seaming operation "Cushion Seal" compound placement was developed. This provides a cushion between the end and the body thus preventing the product from entering into the double seam area and preventing damage to the enamel lining during the double seaming operation.

These are only a few of the soft drink container developments that have emanated from our laboratories but are indicative of the progress made in this comparatively new packaging field.

PROBLEMS INVOLVED IN CANNING SOFT DRINKS

Although manufacturing processes for soft drinks are quite standardized, many complex problems still exist. Some of the problems associated with the various components of soft drinks and their effects on shelf life and container response have already been discussed. Others, specific to the canning of carbonated beverages, are covered below:

Pressure-temperature relationships. The pressure-temperature relationship of canned carbonated beverages follows Henry's Law. However, in order to guarantee a container packed with a known volume of carbon dioxide under varying pressure-temperature conditions, it was necessary to develop a means for relating mathematically various additional factors such as air, degree Brix, and container expansion. An overall expression for calculating the pressures which would be expected to develop under varying conditions was derived in our laboratories and proven by comparing calculated pressures with actual experimental values as illustrated in Figure 1.

The effects of air and the degree Brix on internal pressure were studied. The results presented in Figure 2 show that an increase in air content produces an increase in internal pressure.

The data presented in Figure 3 show that an increase in degree Brix of the beverage also produces an increase in internal pressure.

These results clearly point up some of the variables which must be taken into consideration in determining container specifications for a particular carbonated beverage product.

CONTAINER PERFORMANCE AND SHELF LIFE

Another major consideration in canning carbonated beverages is the effect of the product on container performance. Carbonated beverages have been found to vary in corrosivity from product to product and sometimes in different lots of the same product. These variations have resulted in widely different container response and have made it quite difficult to predict the shelf life of the product when packed in metal containers without a thorough analysis of all of the factors involved.

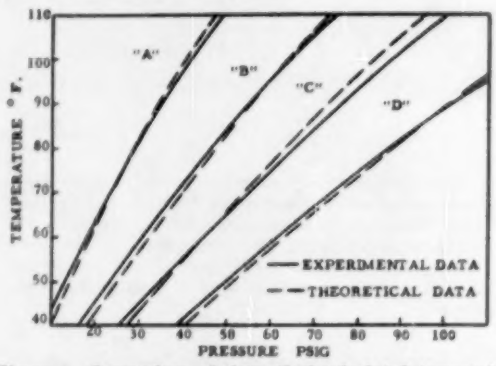

Figure 1. Comparison of theoretical calculated temperature-pressure curves with actual experimental temperature-pressure curves for carbonated water. Conditions given below:

	ml.
Curve A	
Volume of Headspace at 25° C.	35
Volume of Water at 25° C.	340
Volume of CO_2 at 14.6#/in.^{2} pressure	750
Volume of air at 14.6#/in.^{2} pressure	10.8
Curve B	
Volume of Headspace at 25° C.	25
Volume of Water at 25° C.	350
Volume of CO_2 at 14.6#/in.^{2} pressure	1060
Volume of air at 14.6#/in.^{2} pressure	10.8
Curve C	
Volume of Headspace at 25° C.	35
Volume of Water at 25° C.	340
Volume of CO_2 at 14.6#/in.^{2} pressure	1400
Volume of air at 14.6#/in.^{2} pressure	9.0
Curve D	
Volume of Headspace at 25° C.	35
Volume of Water at 25° C.	340
Volume of CO_2 at 14.6#/in.^{2} pressure	1855
Volume of air at 14.6#/in.^{2} pressure	13.0

In view of this, Continental initiated studies in collaboration with the Armour Research Foundation in an effort to develop a rapid means for testing the corrosivity of carbonated beverages which could be correlated with shelf life. A secondary objective of the study was to develop a tool which would give a better understanding of the factors contributing to the corrosivity of this class of food products.

The concerted efforts of these researchers resulted in the development of a "Corrosivity Tester" and a procedure for estimating the shelf life of carbonated beverages when packed in commercial metal containers. The test method is based on the theory that different metals in contact with the beverage create a galvanic potential

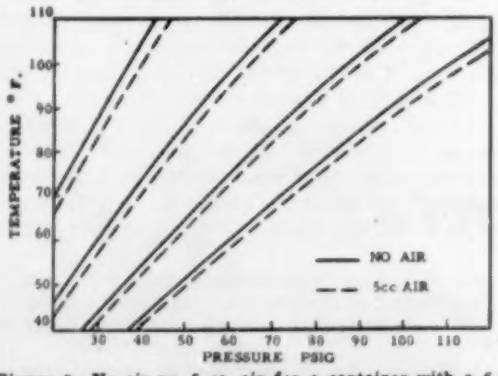

Figure 2. No air vs. 5 cc. air for a container with a 6.7% headspace at 2, 3, 4, and 5 volumes of carbonation and with 0° Brix.

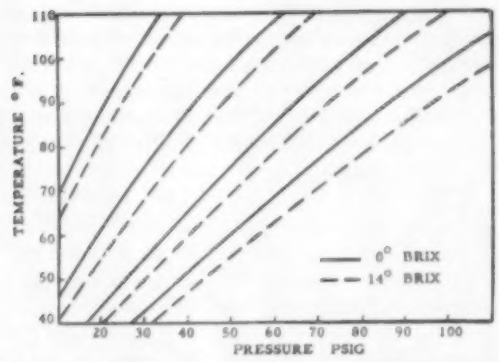

Figure 3. 0° Brix vs. 14° Brix for a container with 6.7% headspace at 2, 3, 4, and 5 volumes of carbonation and with no air. (Volumes of carbonation defined as the amount of car bon dioxide dissolved in the liquid at 60° F.)

which in a closed circuit induces the flow of electrical current providing the driving force to produce corrosion, resulting in iron pick-up and/or can perforations. Thus it is possible to establish a galvanic system with tin and iron electrodes which, when immersed in a carbonated beverage under controlled conditions, will cause different amounts of current to flow between the tin and iron. The quantity of current flowing between the tin and iron is measurable and indicates the corrosivity of the product. It is, therefore, possible to correlate such activity with the shelf life of a particular canned carbonated beverage.

Figure 4 illustrates a curve based on calculated perforation times of cans with 0.0012 square inch area of exposed iron as influenced by various galvanic currents plotted against the actual perforation data of controlled test packs with beverages upon which the galvanic current was determined by the corrosivity tester. Theoretically, it appears that shelf life can be estimated from this curve with very favorable correlation.

The results show certain trends or patterns which justify using the corrosivity tester as a quick method for predicting or estimating the shelf life of carbonated beverages when packed in commercial soft drink cans. However, more correlations need to be made with controlled test packs to establish thoroughly the reliability of this method.

Promising applications have already been made of this tool in modifying beverage formulations to eliminate corrosive ingredients and extend shelf life of the canned product. For example, the artificial food color, amaranth, was found to be contributory to high galvanic currents (high corrosivity). The amount of amaranth color which could be tolerated for the desired shelf life of the product was quickly determined, and the beverage formulation was modified accordingly. Similarly other corrosion-contributing ingredients and their tolerance levels are being investigated with beverage manufacturers.

The corrosivity tester was also used to study the effects of air content on shelf life. Some of these data accumulated are summarized in Table 1. The corrosivity tester readings in samples with high air content are considerably higher than those with low air content. These data are in line with actual test pack data and confirm the belief that the elimination of air in the headspace will greatly prolong the shelf life of canned carbonated beverages.

TABLE 1
Effect of air content on shelf life of canned carbonated beverages

Product	Air content	Average reading microamps x 100	% Perforations Time in weeks					
			5	7	9	13	17	21
Product A	L	34.	0	0	0	0	0	0
Product A	H	510.	0	4	4	12	12	16
Grape[1]	L	81.	0	0	0	4	8	20
Grape[1]	H	610.	4		16	37	45	60
Orange	L	64.	0	0	0	0	0	4
Orange	H	390.	0		4	12	20	25
Root Beer	L	21.	0	0	0	0	0	
Root Beer	H	470.	0	0	0	8	20	
Ginger Ale	L	9.	0	0	0	0	0	0
Ginger Ale	H	510.	0	0	0	8	25	41

(Low air content, below 5 cc.; High air content, above 5 cc.—for cans).
[1] An extremely corrosive product.

As illustrated in Figure 5, the corrosivity tester may also be used as a measuring tool for predicting the amount of iron pick-up by the product. A theoretical curve of the amount of iron in solution (p.p.m.) per month was constructed from mathematical calculations and actual test pack data plotted against the curve. There is significant correlation of microampere reading

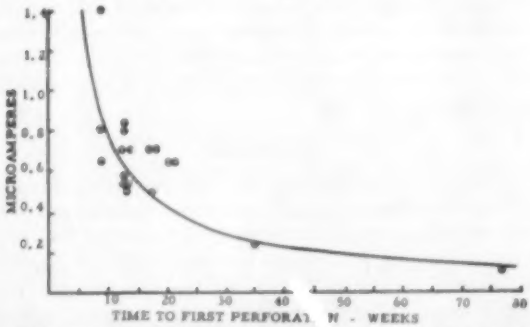

Figure 4. Perforation data from controlled test packs plotted against a curve based on calculated perforation times of cans with 0.0012 sq. in. area of exposed iron.

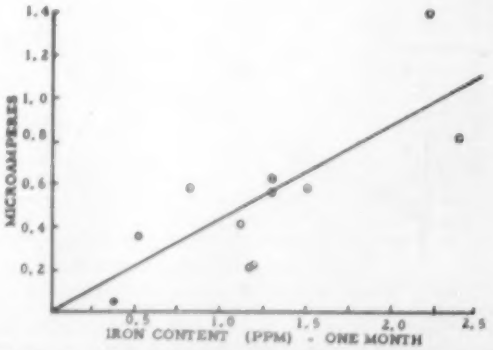

Figure 5. Microampere reading and actual iron content (p.p.m.) of controlled test packs plotted with the theoretical curve based on Faraday's law of electrolysis.

with p.p.m. iron pick-up and the corrosivity tester can be used as an indication of the product's capacity to pick-up iron.

The effects of air content on iron pick-up were investigated and some results of these studies are illustrated in Figure 6. This graph shows that air content

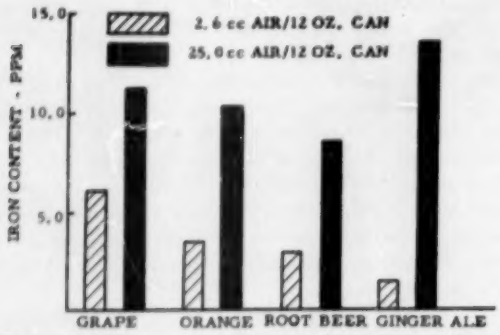

Figure 6. Effect of air content on iron pick-up of various soft drink products stored for 21 weeks at room temperature.

affects the ability of the beverage to pick-up iron and that beverages respond differently, or in varying degrees, to high and low air content. In connection with this figure, it should be pointed out that this experimental pack was made with developmental cans stored at room temperature for a period of 21 weeks. The amount of iron pick-up in products packed with low air content (below 3 cc.) in containers now commercially available would be considerably lower, in the neighborhood of 1 p.p.m. or less for the majority of soft drink products.

Experimental packs with ascorbic acid added to minimize the rate of iron pick-up in products packed with low and high air content were made. The results of the addition of ascorbic acid to a soft drink packed in flat top cans is presented in Figure 7. This figure shows that ascorbic acid is an efficient antioxidant and was effective in reducing the rate of iron pick-up, thus

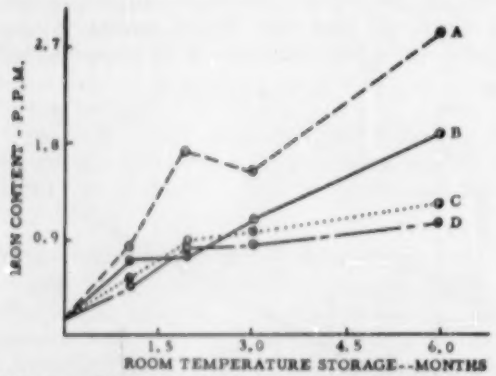

Figure 7. Effect of ascorbic acid on iron pick-up of a soft drink packed in flat top cans. (Curve A—9.7 cc. air/12 oz. can; Curve B—2.4 cc. air/12 oz. can; Curve C—10.2 cc. air + 36 mg. ascorbic acid/12 oz. can; Curve D—2.0 cc. air + 36 mg. ascorbic acid/12 oz. can.)

extending the actual shelf life of the product. This same trend was also found with other soft drink products.

Controlled test packs were made with a variety of beverage products to which varying amounts of copper were added to study the effects of copper on iron pick-up and container performance. Figure 8 shows that

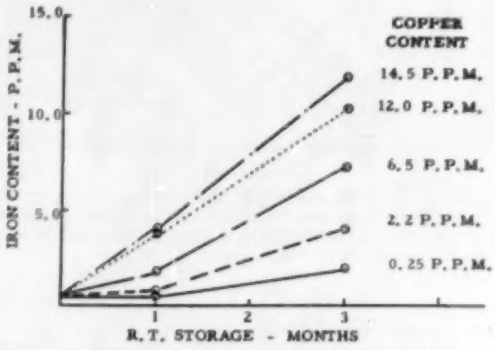

Figure 8. Effect of copper content on iron pick-up of an orange beverage.

increasing the copper content of an orange beverage increased the ability of the beverage to pick-up iron. These data are typical of the results obtained with various soft drink products.

Figure 9 clearly shows the adverse effect of high copper content on container performance. While no

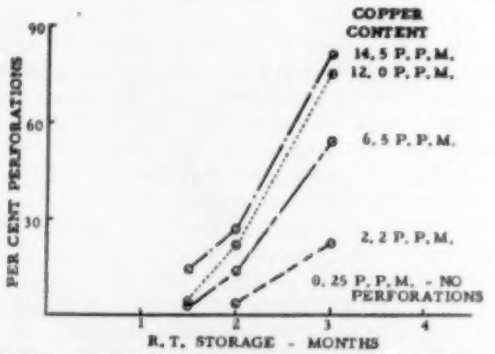

Figure 9. Effect of copper content on container performance for an orange drink.

perforations occurred after three months' storage at room temperature with a copper content of 0.25 p.p.m., more than 80 percent of the containers perforated when the copper content was increased to 14.5 p.p.m. These data show conclusively that high copper content greatly decreases the shelf life.

SUMMARY

Technical improvements in can structure, linings, and can-manufacturing materials and methods coupled with technological advancements in beverage formulations, packaging procedures and methods make canned carbonated beverages one of the most promising and highly technical developments of the present age of modern packaging. Many of the early problems have

been completely overcome; others have been minimized, thus permitting the can manufacturer to guarantee the metal container to have adequate shelf life and to safeguard the flavor and taste of carbonated beverages packed in them. Continuing research promises even further progress along these lines.

The results of developmental work presented in this paper are summarized below:

1. Data show that an increase in air content produces an increase in internal pressure in the container and increases the ability of the product to pick-up iron. Ascorbic acid added as an antioxidant reduced the amount of iron pick-up by the product. Experimental packs with low and high air content confirm the belief that elimination of air in the headspace greatly prolongs the shelf life of canned carbonated beverages. (Figures 2, 6, and 7; Table 1).

2. Results show that an increase in the degree Brix produces an increase in internal pressure for a given volume of carbon dioxide. (Figure 3.)

3. In connection with pressure-temperature relationship studies, a mathematical formula was derived for predicting temperature-pressure curves for any given set of conditions and its accuracy was proved by comparing calculated pressures with actual experimental values. (Figure 1.)

4. A rapid method for testing the corrosivity of carbonated beverages which could be correlated with shelf life was developed. Results show justification for using the method for the purpose intended. (Figure 4.)

5. The "Corrosivity Tester" was also found to be an effective tool for predicting the amount of iron pick-up by the product during storage. Substantiating data are plotted in Figure 5.

6. Studies varying the copper content of the carbonated beverage show that increasing the copper content increases the ability of the product to pick-up iron, and that high copper content is not conducive to extensive shelf life of canned carbonated beverages. (Figures 8 and 9.)

Notes and Letters

Problems in Civil Defense: Report on a Training Course for Food and Drug Officials

The Food and Drug Administration, during a five day training course the week of October 26th in Chicago, gave practical instruction on problems that would confront state and local food and drug officials if we were attacked with nuclear, chemical or biological weapons.[a] Industrial personnel also attended.

Radiation hazards. Approximately two-thirds of the class time was devoted to nuclear attack and the inevitable radiation hazards which follow. The problems which arise, aside from the destruction due to the blast and attendant fires, will be principally those which accompany any natural disaster—ruptured, dirty containers, contaminated food and water and an overall disruption of communications. These will be accompanied by the probable hazard of radioactive fallout contamination. This material consists of particles of the bomb itself, including fission products and unfissioned material, plus particles of earth and water swept up by a low level burst. In order to estimate the rate of decay of this multitudinous array of radioactive fallout material we must resort to an empirical equation, which says that the radiation intensity at any time (t) after the explosion is equal to that intensity one hour after the explosion divided by the number of hours (t) since the explosion raised to the 1.2 power. $I_t = \frac{I_1}{t^{1.2}}$. Estimates of the probable time of safe entry into a contaminated area and the length of permissible working time may then be made from graphs of the above equation. The acute dosage which may result in changes in the blood picture without serious injury is 35 roentgens. Levels higher than this are not advisable for whole body radiation. The hazards of radioactive isotopes in food and water are greater than external radiation for the following reasons:

1. They irradiate body tissue continuously until they are eliminated.
2. The biological half-life of some radio-istopes is very long and in most cases it is difficult, if not impossible, to increase appreciably the rate at which they are eliminated.
3. Sources inside the body are in intimate contact with the body tissue. This enables alpha and low-energy beta radiations—which, because of limited range, do not present an external hazard—to reach radio-sensitive tissue inside the body and to dissipate all their energy in a small volume within a critical organ.

The Atomic Energy Commission has suggested emergency levels for radioactive contamination of drinking water after such an attack. Similar tolerances have been suggested for food. An emergency standard for calibration of a Geiger counter to check the 10 and 30 day safety levels of radioactivity in food or water may be easily prepared. By dispersing 3.14 g. of uranyl acetate in 5 g. of a liquid casting plastic and casting this in the top of a four-ounce ointment tin, one obtains a standard as well as a container for the sample to be tested. The bottom of the container filled to the lower edge of the indentation on the side will provide approximately the same probe to sample distance as the standard. The radiation emitted will be at the upper level permissible for ten day emergency use.

The data available at present indicate that there will be no significant induced radioactivity in food or drugs far enough away from the center of the explosion to escape destruction. Hence the salvage and cleanup operations will have to contend with fallout materials, dust, or mist. The contents of hermetically sealed containers will not be contaminated. However

[a] Full information is contained in *Civil Defense Information for Food and Drug Officials*, Food and Drug Administration, Washington 25, D.C.

cloth or porous paper wrappers may permit redioactive dust or mist to penetrate into the food. These same generalizations are true of biological or chemical warfare agents.

Segregations of the contaminated material, usually the surface area of the stockpile, may uncover usable merchandise. These undamaged portions of the stockpile may then be utilized while the contaminants are being removed from the segregated material. Washing waterproof containers with a detergent, dusting, brushing, flaming or using a vacuum cleaner (if available) may well serve to remove the radiation hazard. The radioactive debris collected should be buried to avoid further contamination.

Biological or chemical attack. The problems of sanitation and salvage in the event of biological or chemical attack would be similar. An incubation period would follow attack with biological agents, consequently the spread of the organism would be more difficult to check. However, rigorous sanitation procedures universally applied should be the first order of business. Cooking all contaminated food in a pressure cooker at 250° F. should be adequate sterilization. If dry heat is used a higher temperature (270° F.) is necessary. Boil all water in the event of any overt attack.

Contamination of food by the war gases may be removed by alkaline hydrolysis, aeration, or segregation. The same procedures of washing with detergent all sealed waterproof containers before opening would apply to both biological and chemical attacks. The use of bactericides should be supervised by someone with knowledge of their chemical, physical, and bactericidal properties.

SUMMARY

In summary, the problems following any attack will be similar to, though vastly more complex, than those following any major disaster. Contamination by sewage, filth, radioactive dust or water, war gases, flying glass, and biological agents may all occur. Each presents its own problems. With the exception of glass splinters in food, a solution exists for each. Embargo, segregation, salvage, condemnation or disbursement must be handled in turn.

The training course was well attended and satisfactorily received by those present. The instructors suggested that the industrial representatives might disseminate the information to their own people, since the local civil defense organizations might be overburdened with detail. They would therefore be unable to conduct such classes.

G. F. HANNA
Research Division, Container Utilization Section
American Can Co.
Barrington, Illinois

Editor, Notes and Letters
FOOD TECHNOLOGY
11606 South Bell Avenue
Chicago 43, Illinois

Dear Sir:

Following the work of Ball at Rutgers and Lee at the N. Y. Agricultural Experiment Station at Geneva, we have been investigating the application of antioxidants to canned foods. Observations on an asparagus pack using N.D.G.A. revealed certain phenomena which seemed worthy of comment. We have been unable to find any literature references to this experience and hope a comment will be helpful to those packing asparagus.

The asparagus pack consisted briefly of samples with and without N.D.G.A. in tin and glass stored in the dark and light. The glassed samples were blanched for 3 minutes at 190° F. in water and hand packed into 8-oz. baby food jars. After covering with hot 1% salt brine and capping at 24" vacuum, jars were processed at 240° F. for 23 minutes. Difficulty in cooling produced a partial cooling for 3 minutes, followed by an effective cool. Tinned and glassed packs were stored in the dark and light.

Glass packs stored in the direct sunlight were completely unpalatable at the end of 3 weeks. There was no visual change, but on opening the odor produced was that of a sulfide-like off-odor. At the end of one month in sunlight stored glass packs the asparagus was noticeably bleached, the brine clear, but the cap was badly stained—black—and the asparagus was strongly offensive, again a sulfide-like odor. In parallel packs of dark stored glass, or light or dark stored tin no similar odor was observed.

From the evidence available to date it would seem that a light-catalyzed sulfur breakdown is being encountered. This work is being continued and will be reported in fuller detail at a later date.

Sincerely yours,

September 13, 1955

WM. J. STANGE CO.
H. P. SMITH
D. J. RIDENOUR
ROY E. MORSE
Director of Research

THE INDEX

TO THIS VOLUME HAS BEEN REMOVED FROM THIS POSITION AND PLACED AT THE BEGINNING OF THE FILM FOR THE CONVENIENCE OF READERS.

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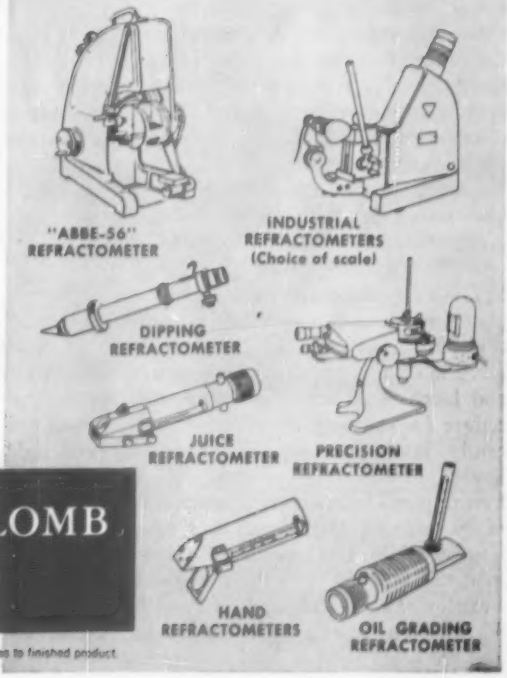

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BOOKS

(Continued from page 28 preceding technical papers)

residues. The food technologist is particularly concerned with the development and use of routine analytical methods for the detection and determination of such residues in raw materials used in processing and in the prepared and processed foods.

The rapid development of a wide variety of agricultural chemicals (pesticides, fungicides, herbicides, growth regulators, etc.) particularly during World War II, led to the establishment of a pesticide subdivision of the Division of Agricultural and Food Chemistry of the American Chemical Society, shortly after the war and the publication of the Journal of Agricultural and Food Chemistry, the first issue of which appeared on April 1, 1953. Francis A. Gunther, associate insect toxicologist in the Citrus Experiment Station of the University of California, who was particularly active in the development of methods of analysis of insecticide residues for over 12 years, has been a member of the advisory editorial board of this journal since its inception. As an example of the activity in this field, 20% of the articles published in 1953 and 1954, dealt with insecticides, and this rate of publication has continued.

The material on insectide analysis is presented in three sections. The first section of 9 chapters (168 pages), deals with general analytical problems encountered in selecting, preparing and analyzing agricultural material for residue. The second section of 1 chapter deals with the general problems of the determination of the major insecticide components in technical grade materials. The third section of 5 chapters (429 pages) discusses sampling, measuring, processing, clean up and analytical methods. In chapter 15, detailed analytical procedures for some 90 insecticides (including inorganic insecticides, such as lead arsenate and Paris green; naturally occurring organicals such as nicotine and nor-nicotine; and synthetic organicals ranging from the older ones, like DDT, to promising new materials like diazinon). A selected and tested procedure for each insecticide is given in detail and additional methods are referred to. Both composition analysis and residue analysis are given in sufficient detail so that even the beginning analyst can intelligently follow them. The book concludes with an appendix in two parts, one giving detailed ultraviolet absorption spectra and the other infrared absorption spectra.

The analytical methods described are largely spectrophotometric and colorimetric, although occasionally titrimetric, polarographic or gravimetric methods are given in detail. Although the general aspects of bioassay and biochemical assay are discussed, no detailed procedure for carrying these out is given. Until quite recently insect bioassay of insecticidal materials was limited to screening of chemicals for selecting those having possible insecticidal value and to standardization of fly spray. Today largely as a result of the investigations of W. M. Hoskins and his colleagues, first reported in detail in 1950, and of subsequent investigations by Frawley *et al.* (1952) and Sun and Sun (1952), microbiossay techniques using houseflies have been developed and are being used in food control and research laboratories. Insects other than houseflies, more sensitive than houseflies, such as the Daphnia spp, were suggested by several workers in 1951. In view of the possibilities inherent in such methods it is unfortunate that the authors devoted less than 4 pages to these techniques.

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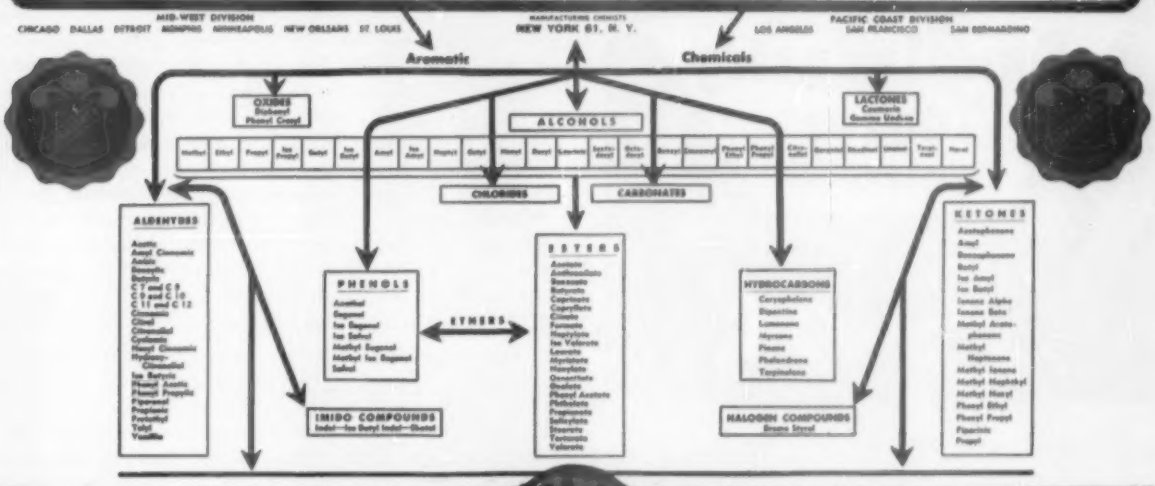

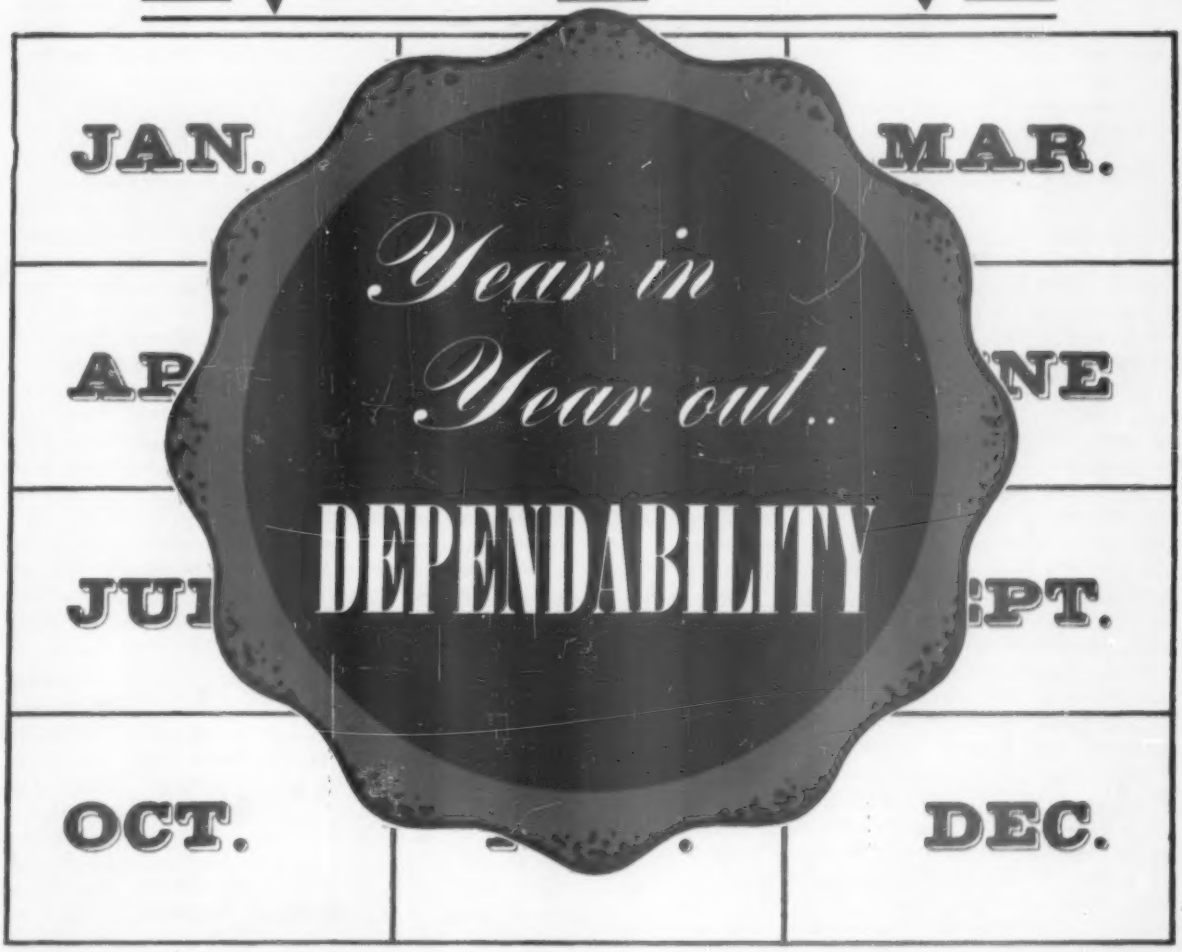

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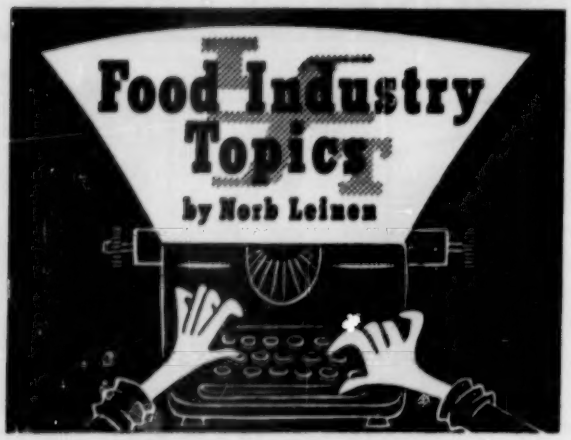

. . . in the public interest

Manufacturers who don't strive continually to improve their products, even to the extent of "obsoleting" their own current lines, are facing certain loss of present and future markets, a leading industrial research scientist recently told the Society of Industrial Packaging and Materials Handling Engineers, meeting at New York University. The scientist, Mr. Roger H. Lueck, vice president in charge of research for American Can Company, stated that industry has awakened to the growing importance of its research branch. The current ratio of one scientist to every 60 industrial employees, compared with the 1900 ratio of one to every 250, shows that industrial research has grown from a "poor relation in the management family" to "one of the four pillars of company organization," along with operation, sales, and finance, he said. Pointing out that the head of a modern research unit must also be an administrator and a businessman, Mr. Lueck cited 4 basic objectives for the research director to keep in mind: (a) produce and maintain the company's current business volume; (b) assure a steady growth in volume; (c) increase the return on dollar sales or dollars invested; and (d) minimize the company's dependence on critical or sensitive raw materials. He predicted the nation's annual research outlay soon will top the $7 billion mark, noting that over $4 billion will be spent this year for such projects, whereas only $500 million was spent 25 years ago.

The president of American Can Company, Mr. William C. Stolk, reported that U. S. can production for 1955 is headed for an all-time record. He said that output of the can-making industry will total about 38 billion containers, estimated on the basis of No. 2 cans. That would be approximately 5% greater than the 36.2 billion cans manufactured in 1954—marking the fifth straight year U. S. can production has attained new highs.

◆ ◆ ◆

New uses for antibiotics in food preservation were described recently by an eminent food technologist who predicted that this development will give the world better, safer, and more varied foods at lower cost. Spoilage of meat, milk, leafy vegetables, poultry, and fish can be averted through use of the same antibiotics that have controlled scores of human diseases, it was reported by Dr. C. L. Wrenshall, associate director, Technical Service Dept., Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn 6, N. Y. He said that antibiotics can be used with or without refrigeration, with the added advantage that they will not cover up damaged, contaminated, or inferior foods. "In addition," he stated, "antibiotic residues may present little or no problem, since antibiotics, relatively unstable compounds, lose activity during storage and are easily destroyed by heat, as in cooking."

◆ ◆ ◆

The Age of Automation, paradoxically enough, will rekindle emphasis on two of the old school-day three R's—reading and writing. The prediction came from the training director for Minneapolis-Honeywell Regulator Co., one of the major contributors to this automatic trend, who foresees this transition from "brawn to brain" jobs causing difficulties for employees and bosses alike. "Today we still live primarily by dealing with words," he said. "The more we advance, the more reading and writing we have to do. And currently we adults are doing that about as capably as grammar school pupils." He pointed out that surveys of the reading ability of top management people when tested on such easy-to-read material as newspapers, indicated they poked along at about 250 words a minute—a seventh grade level. From a penmanship standpoint, we've become a nation of scrawlers, Mr. Scheetz claims. He reported that his own firm was startled into doing something about its employees' penmanship when $65,000 worth of inventory was misplaced because figures of an inventory clerk had been read incorrectly. A voluntary handwriting program involving weekly sessions for employees was well attended. Mr. Scheetz pointed out that according to some estimates U. S. industry spends $10 billion annually helping employees upgrade their skills to improve their jobs and earn more money. To get the full benefits of this training, he cautions them not to over'ook the fundamentals—reading and writing.

◆ ◆ ◆

Confections containing important amounts of milk now are being used extensively in the Armed Forces feeding program, according to Col. John D. Peterman, commandant, Quartermaster Food and Container Institute for the Armed Forces, Chicago. On display recently at the Third International Dairy Show, held in Chicago October 7-14, were 9 confections containing from 3½% to 16% milk solids, and currently being used in the rations. "To most of us when candy is mentioned, we immediately think of sugar or carbohydrates," Col. Peterman said. "In some instances, this is true. But, most of the confections procured by the Armed Services contain necessary nutrients other than carbohydrates. For example, the enriched sweet chocolate bar and disk contain 16% milk solds; vanilla chewy caramels—13%; chocolate-coated vanilla cream bar and disk—11½%; toffee

(Continued on page 40)

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So true to the real chocolate flavor – and *so powerful* – is Givaudan's Imitation Chocolate Arome that extremely small quantities may be used to replace large amounts of cocoa in chocolate-type formulations.

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FOOD INDUSTRY TOPICS

(Continued from page 38)

—10%; chocolate-coated fudge bars and disks, and candy-coated chocolate disks—8% milk solids; caramel rolls and chocolate grain caramels—3½%. Fat, which also is necessary for nutritional balance, is contained in these bars. All of these factors are considered when designing rations to meet the nutritional requirements of the Armed Forces."

◆ ◆ ◆

The average American today owes the last 21 years of his life to medical science, and even greater achievements are in store if medical education is supported, according to Mr. Geo. H. Coppers, president of the National Biscuit Company and chairman of the Food Division of the National Fund for Medical Education, 2 W. 46th St., New York 36, N. Y. The nation's dependence on the teaching and research programs of the 81 medical schools was outlined in detail in a new 6000-word analysis of the crisis, now available. The study, entitled "Handbook for Medical Education," points out that the schools need $10,000,000 additional annual income if they are to meet constantly mounting demands for more doctors and more research.

◆ ◆ ◆

In a semi-annual report of approved medical services in industry, the Occupational Health Institute recently announced that 7 plants in the food industry have been awarded its Certificate of Health Maintenance. The recognition is given to those plants which comply with the standards for medical service in industry as established and approved by the Industrial Medical Assn. Plants within the food industry that have been certified include: Abbotts Dairies, Inc., Philadelphia; Armour & Co., Chicago; Corn Products Refining Co., Argo, Ill.; General Mills, Inc., Minneapolis; Geo. A. Hormel & Co., Ottumwa, Iowa; and National Biscuit Co., Niagara Falls, N. Y. The Institute has officially accredited 248 medical programs, in all sizes of plants and types of industry, throughout the U. S., Canada, and Hawaii. The service is free and each individual medical unit must be evaluated individually. To apply for a survey leading to certification, write to Occupational Health Institute, Inc., 6 E. 39th St., New York 16, N. Y.

◆ ◆ ◆

Polyethylene film may in the future become the universal store wrapping, according to Mr. James F. Bernard, sales manager, The Visking Corp., Plastics Division, Terre Haute, Ind. Speaking of the characteristics of polyethylene film at the recent National Paper Trades Assn. convention in Chicago, the executive stated that the unique properties of the material have made it the ideal transparent packaging film for hundreds of products. He pointed out that with the perfection of new packaging machinery, additional applications will become available. He cautioned, however, that to be used with maximum success, the material should be of good quality, and stated that good raw material can be ruined by poor film manufacturing techniques. "It is up to the end user," he concluded, "to stress quality film when ordering so as to derive the utmost from use of the film."

◆ ◆ ◆

National Sugar Refining Company, New York City, has been voted the "Joshua" award for the most distinguished use of match book advertising in the food industry in 1955, Mr. Chas. Furcolowe, director of the Match Industry Information Bureau, has announced. The Jack Frost Sugar match book was selected by a panel of judges outstanding in advertising and marketing work on the basis of a good match cover design closely related to the special container which resembles the Jack Frost package. The match book program involved a dealer cooperative plan for use as a broker handout. More than 300,000 American business concerns used match books for advertising during the past year. The "Joshua" award is named for the inventor of match books, Joshua Pusey.

◆ ◆ ◆

The Food Section of the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill., has announced changes in divisional set-up. The Canners & Grocers Division heretofore included processors and retailers. Members of the Industrial Agricultural Division and the Ice, Cold Storage and Frozen Foods Division are primarily engaged in preparing and processing food products for sale, and their safety problems approximate those who pack food in cans or any others who prepare food for sale. The Executive Committee of the Food Section decided to eliminate the above 3 Divisions and instead establish 2 new ones: the Food Retailers Division, and the Food Processors Division.

◆ ◆ ◆

The foods and produce industry, represented by 47 firms, played a vital role in the 50th Anniversary celebration of Chicago's famed Central Manufacturing District—first of America's industrial communities—which was highlighted by a Pageant of Industrial Progress, November 8-10. The pageant, a dramatic and graphic presentation of the District's industrial significance and diversification, held in the International Amphitheatre, included nearly 100 activated exhibits which, in keeping with the theme of the event, presented many displays contrasting the old with the most modern industrial production methods. A total of 32 separate industrial classifications are represented on Central Manufacturing District property and the total investment in buildings, machinery, and facilities amounts to approximately $750,000,000.

◆ ◆ ◆

By a four-to-one margin, hamburger buns in cartons outsell buns in cellophane bags, according to the experience of 179 Jewel Tea supermarkets. The study was conducted by the Bakery Package Group of the Folding Paper Box Assn. The third in a series of market tests to determine sales appeal of packaged

(Continued on page 42)

Season's Greetings!
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To all our friends, our sincere wishes for a very Merry Christmas and a Happy and Prosperous New Year.
President
Sterwin Chemicals
1450 Broadway, New York 18, N. Y.
IN CANADA:

FOOD INDUSTRY TOPICS

(Continued from page 40)

bakery products, the Jewel survey showed the widest margin of preference for cartons over straight film wraps. In the 2 earlier studies, a direct comparison between 2 competing supermarkets showed the overwrapped cartons winner by a 2-to-1 margin, and opinion polls by Market Facts, Inc., of housewives and store managers, showed a 3-to-1 preference for carton-protected buns.

◆ ◆ ◆

The nation's food industry can achieve sales increases of nearly 25% by 1960 and almost 50% by 1965, Mr. Paul S. Willis, president of Grocery Manufacturers of America, predicted at the American Bakers Assn. convention recently held in Atlantic City. He estimated that by 1960 the industry can be selling $17 billion more food than at present, and that by 1965 the figure could reach $30 billion more. Total food sales this current year are estimated at $66 billion. Mr. Willis said that the vast growth potential can be realized if, among other advances, the food industry will continue frequent introduction of excellent new products, expand its efforts to sell the public on good nutrition, and find ways of making marketing methods even more efficient. The speaker also stressed the interesting fact that food industry wage rates have risen 38% since the 1947-49 period, but substantial investments in new and improved methods, plants, and equipment have brought efficiencies that have held actual labor costs per unit of goods produced to a 24% rise. "Net result is that labor costs have mounted only three-fifths as fast as wage rates," said Mr. Willis. He pointed out that the divergence is highly favorable to the consumer. "During 1955, food processors are planning to spend nearly $600 million for new plant and equipment," he concluded. "This is a rise of 10% above their comparable new capital expenditures last year, and recent indications are that these investments may be even larger than originally planned."

◆ ◆ ◆

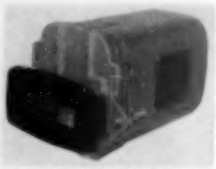
There's apparently no holding back the hot dog! Hot-dog-hungry Americans broke all records this year for consumption of the tasty franks during the peak season from Memorial Day to Labor Day. Tee-Pak, Inc., 3520 S. Morgan, Chicago, which makes the skins for the skinless franks, reports that American wienie worshippers put away 2,656,729,500 pups during that period—an average of 16.16 per person.

◆ ◆ ◆

Atlanta Paper Company recently sponsored the first annual "Painting of the Year" Art Competition and Exhibit. The competition was open to artists in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. The first-prize painting, designated "Painting of the Year," will be reproduced in full color and sent out at Christmastime to over 10,000 customers throughout the world.

. . . things new under the sun

A new, highly accurate valve positioner and a camless integrator which works on the centrifugal principle are announced by The Foxboro Co., Foxboro, Mass. Designed for precise control action, the type C Vernier Valvactor overcomes friction and reduces line effects, speeding valve response to controller signal. Its applications include large-volume diaphragm motors and processes where controller-to-valve distances are long. Extremely compact, the positioner is only 6⅜" by 6¼" by 5 5/16" (with gauges and switch); mounts directly on valve yoke.



New Foxboro Model 14A Pneumatic Integrator

The Model 14A Pneumatic Integrator, unique in that it requires no cams for square root extraction, provides continuous linear integration of industrial process flows to within ½% accuracy. The device is weatherproof, dustproof, and self-purged; can be panel- or field-mounted. Gears are replaceable for whatever unit of flow measurement is desired. All circuits are pneumatic; conventional 20 p.s.i. air or gas supply required.

◆ ◆ ◆

The Instrument Division of American Optical Co., Buffalo 15, N. Y., announces a Remote Indicating Rapid Scanning Spectrophotometer, a Pulsing Attachment for the Rapid Scanning Spectrophotometer, and lower prices on these instruments and their accessories. The AO Remote Indicating Spectrophotometer is a new version of the AO Rapid Scanning Spectrophotometer and includes all of the revolutionary features built into the original instrument—such as spectrum scan cycle of about 6 milliseconds, curve redisplay rate of 60 curves/second, and general simplicity of operation. The new Pulsing Attachment permits the operator a choice of one or 6 spectrum scans/second in addition to normal 60 scans/second—invaluable in studying slow reactions, principally in biochemical fields. Revised prices are as follows: Remote Indicating Spectrophotometer, $2,916; Standard Rapid Scanning Spectrophotometer, $2,396; Pulsing Attachment, $296; Reflection Attachment for opaque surfaces, $297.

◆ ◆ ◆

A new test of acid and salt in pickle brine has been developed through the joint efforts of the Morton Salt Company and the National Pickle Packers Assn. The test, available in a compact kit form approved by the Research and Development Committee of the Pickle Packers Assn., enables a pickle processor to quickly, simply, and accurately determine the acid and salt content of pickle brine. Yet, the test is compact, practical, and versatile enough to be used right next to the can line or in the laboratory. Testing for both the salt and acid is done through the use of the one test kit, in which a sample of pickle brine can be tested by titration methods for acid and then for salt content. The object of this test is to promote

use of quality control methods in pickle plant processes. To assure accurate testing and to take the guesswork out of matching titration colors, a stirring rod has been made which encloses scientifically balanced titration end point colors and is available for use with the test. Testing procedure and Color Standard Stirring Rod are available free of charge from Morton Salt Co., 120 S. LaSalle St., Chicago 3, Ill.

◆ ◆ ◆

Abbott Laboratories, North Chicago, Ill., has commended a National Research Council Committee report which declared that unrestricted use of cyclamate in dietetic foods and beverages is "without hazard to health." Mr. Edw. J. Matson, Abbott's director of scientific relations, said the Food Protection committee of the NRC's Food and Nutrition Board had "taken a strict yet fair attitude" in its report. The Committee, in its final report, held that saccharin, in use since late in the 19th century, is "relatively nontoxic." The same is true of the newer sweetener, cyclamate, the Food Protection Committee concluded.

◆ ◆ ◆

Quick change-over, ease of cleaning, and high speed are features of a **new filler** developed by F. L. Burt Co., 571 Seventh St., San Francisco 3, Calif. Known as "Simplex" Model A, this semi-automatic filler deposits one to 32 ounces of many types of drug products into bottles, jars, and plastic containers. Single piston filler, made of acid-resistant contact parts, dispenses automatically at rate of 15 to 30 containers per minute. Designed for space-saving areas, it fills liquids and semi-solids. Dismantles for cleaning in less than 5 minutes.

◆ ◆ ◆

A new air dryer, originally developed for use with a precision infrared spectrophotometer, now is available from Beckman Instruments, Inc., Fullerton, Calif. Fully automatic, the air dryer delivers air with less than 1% R.H. It can be used with infrared spectrophotometers in low temperature studies to prevent moisture fogging glassware, windows, or mirrors; in balance inclosures or wherever reactions must be carried on under moisture-free conditions. A 24-hour instrument, the air dryer employs activated alumina as drying agent. The dryer will deliver 100 cubic feet of dry air per hour all day long, then regenerate automatically at any selected time.

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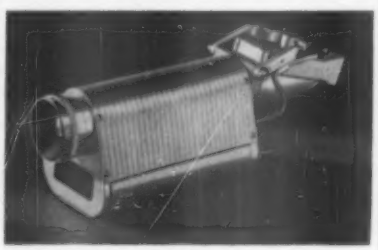
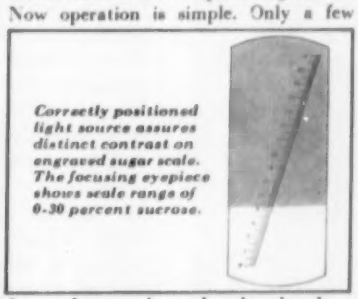
New AO Hand Refractometer Determines Dissolved Solids Instantly!



New AO Hand Refractometer with anodized aluminum finish

Here's real news for food processors and growers! With AO's new Hand Refractometer accurate readings of the percentage of dissolved, solids, particularly sucrose, are made on the spot . . . instantly! Gone is the need for any reference to a thermometer or to temperature correction tables. The secret? AO's design engineers have simplified the temperature correction procedure by means of an exclusive, internal compensating device. Now operation is simple. Only a few drops of a sample need to be placed on the surface of the measuring prism. Using either transmitted or reflected light, the refractometer provides *immediate readings* from an internal graduated scale (range: 0-30 per cent sucrose) which is visible through the focusing eyepiece. Accuracy is assured to 0.1 percent.



Correctly positioned light source assures distinct contrast on engraved sugar scale. The focusing eyepiece shows scale range of 0-30 percent sucrose.

A built-in light source assures ideally positioned illumination under all conditions. Made of anodized aluminum, the new refractometer is light weight, easy to clean. An ever-ready top grain leather carrying case permits use of instrument without removal from case.

If you test raw products for ripeness; if you process fresh juices, syrups, tomatoes, etc., write Dept. S190, American Optical Company; Buffalo 15, New York, for complete information on the new Refractometer. Ask for CATALOG 190

Light wherever you go! Opening on underside of carrying case shows thumb button for built-in light source

American Optical

INSTRUMENT DIVISION, BUFFALO 15, N. Y.

NIAGARA "No-Frost"

SUCCESSFUL IN BIG INSTALLATIONS

PRECOOLING

2 Niagara Spray Coolers pre-cool 3500 boxes of pears per 24 hours—total storage capacity 40,000 boxes

FOOD FREEZING

Hardening 10,000 gal. of ice cream per day at —30° F.

FROZEN FOOD STORAGE

Room 80 ft. x 135 ft. Temperature —5° F.

NIAGARA "No-Frost" gives you extra capacity and better operation. It improves quality, especially in foods, where it brings the product to correct temperature faster and holds it without fluctuation. It saves money for you in the cost of power and labor. There is never any "de-frosting" loss of time or temperature rise

Write for Bulletin 105

NIAGARA BLOWER COMPANY

Dept. FT., 405 Lexington Ave.
New York 17, N. Y.

Sales Engineers in Principal Cities of U. S. and Canada

FOOD INDUSTRY TOPICS

An amazing new product called Bake-Wip, offered for use as a frosting, filling, or icing, keeps without refrigeration for months and requires no special handling on the part of the baker except to chill and whip. One quart of Bake-Wip reportedly yields 2½ quarts of topping that stays sweet and edible for days after it has been whipped and applied to bakery products. The user can sweeten or flavor the product as he desires with no waste or souring, and the flavor can be enhanced further by adding whipping cream (up to 25%). Manufactured by Fount-Wip, Inc., a subsidiary of Reddi-Wip, Inc., Los Angeles, Calif. For information, write the firm c/o Ruthrauff & Ryan, Inc., 3440 Wilshire Blvd., Suite 1212, Los Angeles 5, Calif.

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A conveyor belt featuring **greater resistance to penetration of vegetable and animal oils and fats** has been developed by Hewitt-Robbins, Inc., Stamford, Conn. Made with a nitrile synthetic rubber cover, the belt is designed for use in food processing plants and feed mills. In laboratory tests, the nitrile cover was compared with 2 others in a walnut oil immersion test. After 6 weeks at room temperature, the nitrile cover had not swollen at all; the second cover showed a 38% swell; the third a 74% swell. The belt has a light tan cover easy to keep clean. It will be made with a smooth top for horizontal haulage, and a rough top for inclines and declines.

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Inauguration of an **in-plant vending machine operation** that will offer office workers their choice of 14 hot plate lunches and 13 favorite heavy soups is announced by H. J. Heinz Co., Pittsburgh, Pa. The hot meal vendor is an exclusive development of Heinz and Mills Industries, Inc., vending machine manufacturers. In addition to industrial use, the vending machine operation also will be available eventually for office buildings, schools, hospitals, and other locations where people want hot foods of guaranteed quality, cleanliness, and uniformity. Each machine carries 6 varieties of foods. If only one machine is used at a location, varieties may be rotated regularly according to their popularity. In larger locations, a number of machines may be installed to offer as many varieties as desired. Each machine holds 144 portion-size tins, and the heating element assures service at a steady 150° F. temperature. Because of the service in individual portion tins, the machine offers simple maintenance with no tubes, tanks, or valves to clean. For fuller information, write Mr. Robert P. Lytle, Ketchum, MacLeod & Grove, Inc., 411 Seventh Ave., Pittsburgh 19, Pa.

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The Imperial Automatic Bread Pan Greaser features a new type nozzle which provides **improved distribution of grease all around the inside of bread pans.** The new design eliminates any in-and-out-of-the-pan nozzle action, dispensing whatever quantity of grease is required, handling any kind of grease, and greasing any size or type of bread pan at speeds up to 180 pans per minute. Adjustments for change in

size of pans can be made in a few seconds. Splash-proof sides and movable shield keep grease from spattering on the floor, assuring positive cleanliness. The unit can be rolled easily to bakery production lines, and casters can be raised or lowered to make the unit fit any height conveyor line. All moving parts are raised above the floor, and the unit is stainless steel enclosed. Manufactured by Imperial Machine Co., Inc., 925 N. Darien St., Philadelphia, Pa.

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A completely new idea in animal feeds—ODORAMA, Aroma Feed Enhancer—has been introduced by Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y. Not a flavor, but an "odor," ODORAMA has been tested and proven effective in both mash and pellet form, not only for weanling and piglet, but also as an important factor in continued maximum feed utilization by the hog throughout the entire feeding period. It is available also in specific forms for cattle and poultry feeds.

The firm also announces 2 other new developments. Oleoresin Turmeric, an important product used primarily for its color value, has been added to the extensive line of D&O Oleoresins. Price per pound in 25-pound cans is $3.10. A new powdered vanilla product based on natural vanilla extractives reinforced with aromatics and possessing unusual fixative values, SUCRANILLA promotes long shelf life in products such as dry puddings, desserts, and cake mixes, and can be used advantageously in flavoring powdered milk drinks and ice cream. Price in 100-pound bulk is $0.85 per pound. Trial quantities and further information on both Oleoresin Turmeric and SUCRANILLA available on request.

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A new process for producing an improved animal feed supplement from fish sources has been developed by Prof. Milton E. Parker, director of food engineering at Illinois Institute of Technology, 35 W. 33rd St., Technology Center, Chicago, Ill. The product, a combination of industrial (trash) fish and whey, reportedly is 3 to 5 times as potent in unidentified growth factors as conventional animal feed supplements. IFT member Parker believes the pasty end product of the process will have a higher nutritive value and be more readily digestible in current animal feeds, in addition to being more potent in growth factors. Prof. Parker and 14 New Bedford, Mass., men have formed the Sea Products Corp., which recently set up a pilot plant for testing the product and process at the New Bedford Institute of Textiles and Technology. Patent is pending on both the product and process, which has been assigned by Prof. Parker to the corporation.

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Wherever high-pressure, high-capacity compression of either air or other gases is required, the new "Standardaire" intercooled compressor is recommended. Available in capacities of from 100 to approximately 4000 c.f.m., ranging from 15 to 600 h.p., the largest size weighs only 7700 pounds. Compressor includes a pair of positive-displacement, axial-flow blowers, arranged to work in 2 stages to boost discharge pressure up to anywhere in a normal range

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advantages:

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- More economical because they are more concentrated, yet readily diluted in your own plant.

Write for your copy of "Questions and Answers" for the food processor. Learn how the development of Magna Spice Concentrols has modernized the seasoning of food products . . . and cut seasoning costs.

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FOOD INDUSTRY TOPICS

of from 15 to 50 p.s.i.g. With appropriate inlet pressures, discharge pressures up to 125 p.s.i.g. are possible. For gas service, the compressor is equipped with mechanical seals; for air, with labyrinth seals. Address Read Standard Corp., 370 Lexington Ave., New York 17, N. Y.

◆ ◆ ◆

The Special Purpose C.R.C. Labwasher **solves specialized problems of washing, rinsing, and drying** various types, sizes, and shapes of laboratory glassware. A joint development of Westinghouse Electric Corporation and The Chemical Rubber Co., the automatic unit is ideal for use where glassware must be completely free of normal water deposits and where hot or cold water will not work alone, but where a combination of both is required. The Special Purpose C.R.C. Labwasher is successful in removing blood from culture tubes, microscope slides, and other types of glassware. It is reported to virtually eliminate breakage. Write The Chemical Rubber Co., 2310 Superior Ave., Cleveland 14, O., for Bulletin L-A-12.

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Latest additions to the line of Swagelok Tube Fittings—Swagelok Galvanic Insulators of Zytel (Du Pont trade mark) polyamide resin—offer a new method of eliminating galvanic action which results from joining dissimilar metals. With their use, brass, aluminum, copper, and steel now may be joined. Moreover, they will find many applications at junction boxes, panel boards, and bulkheads. The insulators are made in a complete line of shapes and in 1/16" to 1" tube and pipe sizes. Address Crawford Fitting Co., 884 E. 140th St., Cleveland 10, O.

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A unique machine, the Ty-Peeler, that automatically removes cellulose casings from wieners at a rate of 400-600 pounds per hour, manufactured by Linker Machine Co., Newark, N. J., presented a problem in lubrication. Sanitary regulations require a nightly washdown, so without automatic lubrication, 26 points on the machine would require daily hand lubrication, with resultant loss of time and unevenness of application. The answer was an automatic lubrication system manufactured by Bijur Lubricating Corp., Rochelle Park, N. J., which automatically supplies exact amounts of oil to the 26 lubrication points on a predetermined cycle. For details, write Mr. Donald J. Coombs, O. S. Tyson and Co., Inc., 230 Park Ave., New York 17, N. Y.

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A "dream truck" that might revolutionize retail delivery operations of bakerymen was exhibited October 1-6 at the 1955 Baking Industry Exposition in Atlantic City, N. J. Besides building prestige for bakeries by its futuristic appearance, the GMC truck also would give the baking industry a lower, more easily accessible, and large-capacity delivery vehicle. Its features include a front-wheel drive, a high visibility driving compartment in front of the engine, Hydra-Matic transmission, and up-swinging rear doors. A wheelbase of 107" and over-all length of 188" give it excellent maneuverability and more positive control on sharp turns. The floor is only 13" above the ground. Although L'Universelle is strictly a "show truck" at present, plans are being pressed to put it into production by GMC Truck & Coach Division, General Motors Corp., 660 South Boulevard, East, Pontiac 11, Mich.

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How a small or medium-sized company can arrange to finance the cost of a complete industrial laboratory for research, cost control, or product development to meet today's competition was disclosed by the Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago 22, Ill. Mr. J. O. Bengston, president of the firm, announced that Chicago Apparatus Company had entered into an agreement with Walter E. Heller & Co., Chicago, a commercial financing firm, to handle financial arrangements for purchasers. Up to 75% of the cost of equipment, apparatus, and supplies can be financed over a 3-year period. Thus, he added, a purchaser of a $5000 laboratory would pay only $1250 in cash, with monthly payments less than $125. Up to 10% of the total purchase can be expendable supplies. Upon application, interested companies will be contacted by Chicago Apparatus technical representatives, who will help plan the laboratory establishment or expansion, as well as the financing arrangements. Representatives also can advise as to the number and type of personnel needed to staff the laboratory.

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Sixteen tons of tough green bone per hour reduced to minus one-inch size is the dramatic performance of the new PB-15 model Rietz Prebreaker. Now fabricated with more massive working parts, the unit is able to handle materials that ordinarily must be assigned to the much heavier, costlier PB-24. Discharge capacity is increased substantially without an increase in operating speed. In the 16 ton-of-green-bone-per-hour run mentioned, the PB-15 was operating with 30 h.p. at 80 r.p.m., and was started under full load. This stop-start cycle was repeated without difficulty under full load during the course of the operation. Tough materials that resist normal disintegration equipment, and oversize materials that cannot be whole-fed to existing machinery may be sent to Rietz for tests on the PB-15 Prebreaker. Processed samples and a complete laboratory report will be submitted after testing. There is no charge for this service. Materials to be tested, along with reduction specifications, should be shipped to Rietz Mfg. Co., Santa Rosa, Calif. Rietz Sales & Engineering offices in St. Charles, Ill., Scotch Plains, N. J., Atlanta, Ga., and Houston, Texas, also can supply further information.

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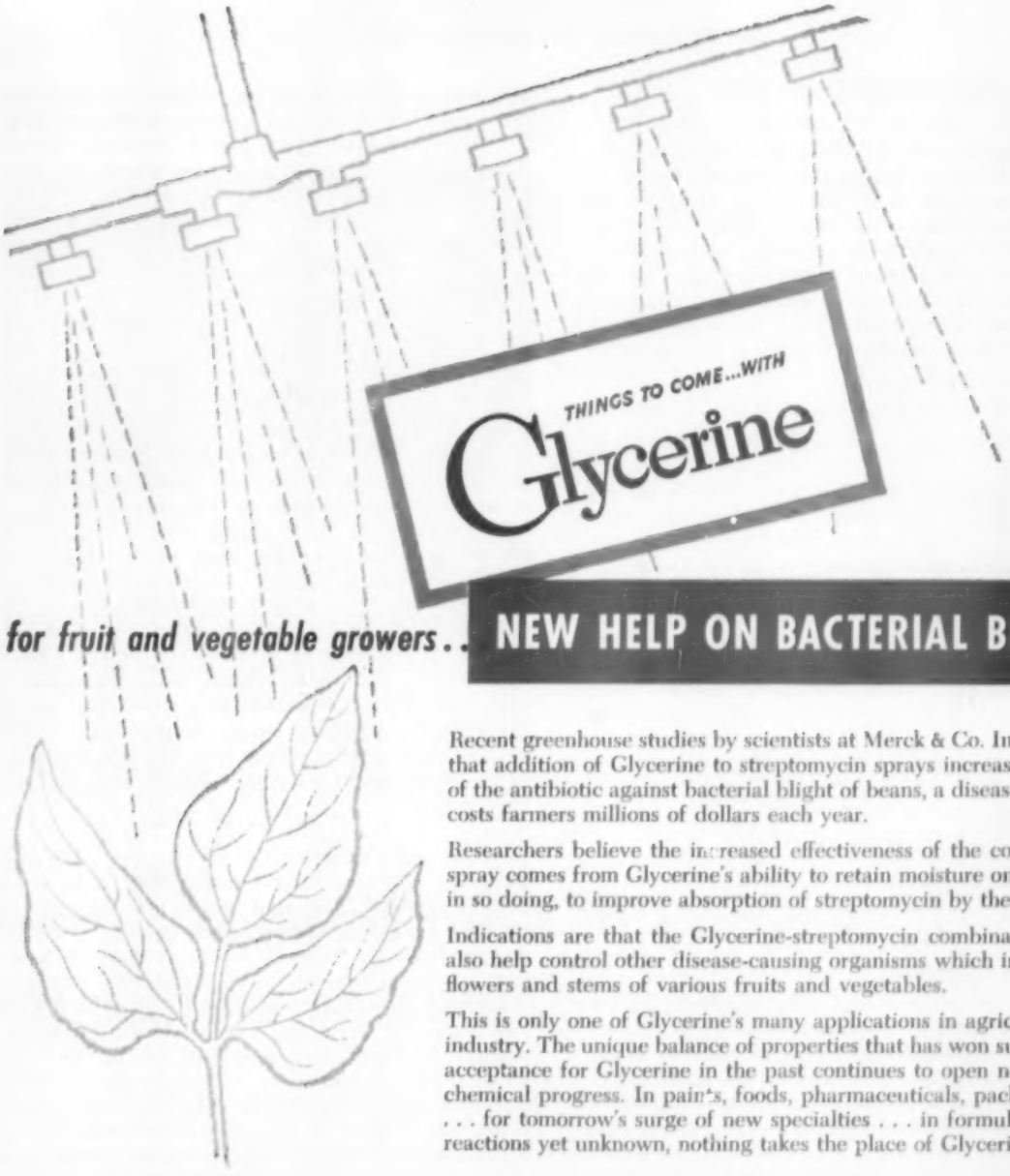
An armored purge meter—the first of its kind—has been developed by Fischer & Porter Co., Hatboro, Pa., manufacturers of complete process instrumentation. Featuring all-metal, rugged construction—1500 p.s.i. ASA pressure rating—combined with low cost, the meter gives safe, inexpensive metering of any purge

(Continued on page 48)



THINGS TO COME...WITH

Glycerine

for fruit and vegetable growers..

NEW HELP ON BACTERIAL BLIGHT

Recent greenhouse studies by scientists at Merck & Co. Inc., show that addition of Glycerine to streptomycin sprays increases the effect of the antibiotic against bacterial blight of beans, a disease which costs farmers millions of dollars each year.

Researchers believe the increased effectiveness of the combined spray comes from Glycerine's ability to retain moisture on leaves, and in so doing, to improve absorption of streptomycin by the plant.

Indications are that the Glycerine-streptomycin combination will also help control other disease-causing organisms which infect leaves, flowers and stems of various fruits and vegetables.

This is only one of Glycerine's many applications in agriculture and industry. The unique balance of properties that has won such wide acceptance for Glycerine in the past continues to open new doors to chemical progress. In paints, foods, pharmaceuticals, packaging . . . for tomorrow's surge of new specialties . . . in formulations and reactions yet unknown, nothing takes the place of Glycerine.

This balanced group of properties keeps **Glycerine's** usefulness growing

HYGROSCOPICITY • STABILITY • HUMECTANT •
SOLVENT POWER • VISCOSITY • NONVOLATILITY • CARRIER • SOLVENT • LUBRICANT • SOFTENER •
NONTOXICITY • TASTE • MW/HYDROXYL RATIO • EMOLLIENT • ANTI-FREEZE • ALKYD BASE •

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☐ 8-page booklet on "Federal Specifications for Glycerine"

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For your free copy of any or all of these booklets write: **GLYCERINE PRODUCERS' ASSOCIATION** • 295 Madison Ave., New York 17, N.Y.

FOOD INDUSTRY TOPICS

(Continued from page 46)

fluid. It is suitable for use in any chemical or processing installation where purging is required. Available from stock in two sizes: (1) 25 g.p.h. or 103 s.c.f.h. of free air, and (2) 80 g.p.h. water or 330 s.c.f.h. of free air equivalent. It is not recommended for gas service below 60 p.s.i.g. A ½" Hoke needle valve suitable for 3000 p.s.i. can be furnished at extra cost. Both sizes of the Figure 245 Armored Purge Meter are priced at $60 list. Write the firm c/o Gray & Rogers, 12 S. 12th St., Philadelphia 7, Pa.

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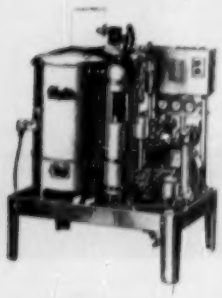

Occupying less floor space than a stenographer's desk, the **new Clayton 15 h.p. forced circulation steam generator with balanced feed** introduces a revolutionary forward step in steam production for food processors and other small volume steam users. Low price and miserly fuel consumption are outstanding features. Four models of the 15 h.p. generator are available to meet varying needs. Manufactured by Clayton Mfg. Co., El Monte, Calif. For information, write Franklin Associates, 2022 S. Mesa St., San Pedro, Calif.

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Podbielniak, Inc., 341 E. Ohio St., Chicago 11, Ill., has completely redesigned its **FLO-KOLD low-temperature circulating refrigerant unit,** originally marketed in 1945 as an auxiliary to the well-known HYPER-CAL high-temperature fractional distillation apparatus. The new model incorporates a cascade assembly of 2 Freon compressors which will produce a supply of coolant at —75° F., held constant within plus or minus 1° F. This temperature is obtainable in 90 minutes, starting from normal room temperature. The 1955 unit features quiet operation, light weight (395 pounds), low power requirement (940 watts), easy portability, and attractive appearance. Floor space required is only 25" by 25". A circulating pump, handling a low-melting-point, low viscosity coolant, will pump 400 g.p.h. @ zero head to 40 g.p.h. @ 10 foot head. Quiet operation of this portable unit permits its use directly adjacent to HYPER-CAL, MINI-CAL, continuous columns, or elsewhere in the laboratory where a readily available supply of sub-zero coolant is required.

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Valuable for indicating r.p.m., operations, cycles, angular and linear motions, for actuating electronic counters, for controlling electrical devices when used with amplifiers and relays, and for synchronizing special-purpose cameras, torsional displacement, and other applications, the **new Electro Magnetic Pickup, Model 3030,** is a small, rugged, impulse-generating transducer which converts mechanical motion into sufficient electrical energy to operate electronic devices. The Model 3030 is an extra-sensitive modification of the standard Model 3010-A Magnetic Pickup. It is intended for use as a supplementary pickup to extend the Magnetic Pickup's usefulness into the slow speed or very low excitation range. Under low excitation, the voltage output is over two times that of the more rugged Model 3010-A. The sensitivity found in Model 3030 is available also in Model 3010-HTAN, designed for use at temperatures up to 500° F. For detailed bulletin, write Electro Products Laboratories, 4505 N. Ravenswood Ave., Chicago 40, Ill.

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PERMAPEX, a new type crayon, combines permanence with removability. The product allows carefully constructed graphs, charts, and diagrams to remain on most surfaces indefinitely. Fluctuating figures or other elements may be drawn in with chalk—washed off without damage to the basic chart. When the project has been completed, the crayon markings are removed easily with APEX-REMOVO, a special solvent provided by the manufacturer. The PERMAPEX Kit consists of 4 APEX-PERMANENT CRAYONS—red, white, yellow, and blue—plus a large tube of APEX-REMOVO. Quantity prices available to industrial users. Single kits may be ordered at $3.25 each direct from the manufacturer. Apex Permanent Crayon Co., 235 Lora Ave., Youngstown 4, O.

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Breads and high protein flours now are being commercially produced for retail and bulk sales, using SHEFTENE C2, food grade casein manufactured by National Dairy Products Corp., and made available through National Dairy's subsidiary, Sheffield Chemical Co., Inc., Norwich, N. Y. Laboratory studies reportedly show that white bread containing 3.3% casein and 3% nonfat dry milk solids is nutritionally superior to bread containing 12% nonfat dry milk solids. This combination overcomes the handling problems of doughs associated with high levels of milk solids. In addition, crust color is not affected and bread texture is fine. A report on this subject, presented at the recent ACS meeting in Minneapolis, is available from Sheffield Chemical Co. It is entitled, "The Nutritional Value of White Bread Supplemented with a Concentrated Milk Protein—Casein."

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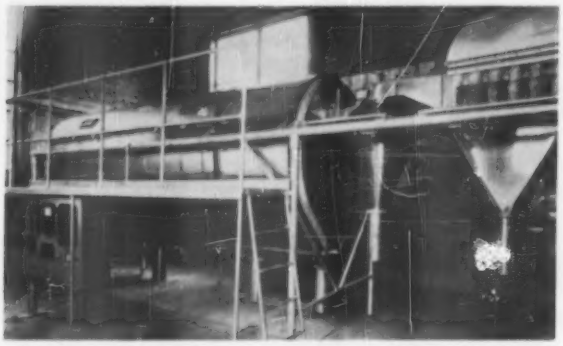
A new line of Hydro-Ejector jet pumps, designed to transport solids through pipelines, is announced by The Allen-Sherman-Hoff Co., 259 E. Lancaster Ave., Wynnewood, Pa. The A-S-H Hydro-Ejector is available in 4 sizes, for 4", 6", 8", and 10" transport pipelines. Because the jet nozzle tip is located out of the path of the materials being handled, it cannot interfere with the free flow of solids. Iron pyrites can be transported in the same system which conveys bottom ash or furnace slag. This combined operation not only saves time and water, but uses the greater specific gravity of a water-and-ash mixture to carry the heavy pyrites at a higher rate. The unit can be

equipped with special gaskets to withstand the effects of acids, alkalis, and high temperatures.



New Buflovak spray dryer with nozzle-atomization in the research laboratory of Buflovak Equipment Division of the Blaw-Knox Co., Farmers Bank Bldg., Pittsburgh, Pa., will be used to develop techniques for spray drying chemicals, pharmaceuticals, foods, and other materials. Materials are dried in a horizontal stainless steel chamber in contact with a hot air stream. Control panel is under the cat-walk (left), and the centrifugal and multi-cyclone collectors are connected with the discharge end (right) of the chamber. Advantages claimed for the dryer are: (1) fast drying at minimum temperatures; (2) extreme flexibility in application to products that can be atomized through a nozzle; (3) requirement for no more head room than normal available in industrial plants; and (4) ease of cleaning.

The Westronics Miniature Strip Chart Recording Potentiometer, weighing less than 25 pounds, now is available with standard charts and ranges for Copper Constantan, Iron Constantan, and Chromel Alumel Thermocouples, and has internal cold junction compensation. This Recorder, of the null balance potentiometer type, records on a 5" strip chart, with a pen speed of one second full scale, and an accuracy of better than 0.5%. Standardization is continuous and automatic; no standard cell or batteries are used. A variety of chart speeds is available, with 3-speed Chart Drive optional. Over-all dimensions are 9⅞" by 8½" by 16½". Auxiliary Control features available. Contact Westronics, Inc., 3605 McCart St., Fort Worth, Texas.

Sorbic now is being produced at South Charleston, W. Va., in a new unit with capacity in excess of 1,000,000 pounds per year, according to announcement by Carbide and Carbon Chemicals Co., a Division of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N. Y. Sorbic, Carbide's refined sorbic acid for food use, controls undesirable growth of yeasts and molds. Use of Sorbic to prevent mold growths is claimed in U. S. Patent 2,379,294, held by The Best Foods, Inc., which firm has licensed Carbide and Carbon Chemicals Co. The purchase of Carbide's Sorbic carries with it a sublicense to the user. Examples illustrating use of Sorbic in protecting food quality include inhibition of spoilage of fresh citrus products due to yeast fermentation, protection of sliced process cheese by means of Sorbic-treated

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It will be worth your while to find out how an extremely small amount of ***dbpc***—as little as 1 part in 10,000—added to the product at the time of processing can effectively inhibit deterioration, reduce waste and save you money. For complete information, write to Koppers Company, Inc., Chemical Division, Dept. FT-125, Pittsburgh 19, Pennsylvania.

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FOOD INDUSTRY TOPICS

wrappers, and reduction of incidence of bloated pickles and control of scum yeasts when added to cucumber brines in small amounts.

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The new VirTis FREEZE-MOBILE has been announced by E. Machlett & Son, 220 E. 23rd St., New York City. The unit provides all elements necessary for freeze-drying procedures compactly mounted on an easy-to-clean, polish, stainless steel cart. The lower shelf of the 2-shelf cart contains a ⅓ h.p., 115 volt, A.C. "Duo-Seal" pump and a large-capacity stainless steel trap. Upper shelf has a McLeod Gauge and a Macro Freeze Drying Unit with a 1.2 liter drying capacity, 2.8 liter solvent chamber, and 12 drying ports. For large-scale freeze drying, a super drying unit with an 8 liter drying capacity, 8 liter solvent chamber, and 18 drying ports is available at additional cost.

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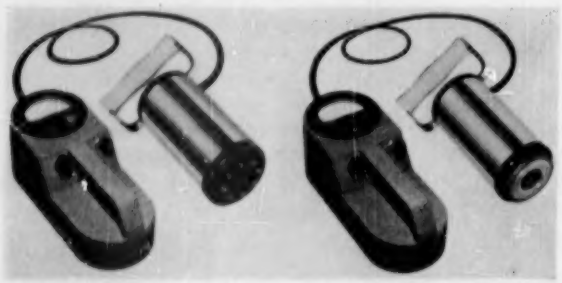

New refinements in electronic components and techniques of moisture measurement of "paper" materials have been announced by Moisture Register Co., P. O. Box 910, Alhambra, Calif. The technical advances, incorporating the latest in miniature electronic tubes, permit sensitive moisture indication in a variety of substances heretofore not measurable by the quick electronic means. These include cellophanes, many of the newer sheet plastics, polyethylene bags, hard board, new types of asbestos-cement siding and roofing insulating materials, gypsum board, sheet rock multi-wall bags of various types, and other materials in which moisture is an important factor. Two models are available. Model "K1", left, has spring-loaded button electrodes for measuring irregular or curved surfaces, has an electronic penetration of 1", and is designed for testing rolls or stacks of paper or paperboard. Model "V2G", right, has a large electrode for use on individual thicknesses or thin stacks, has a penetration of ⅛". Both models operate on a patented principle of high frequency power absorption, permitting measurements to both higher and lower moisture ranges than instruments using conventional principles.

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A unique new method of corrosion protection for equipment now is being utilized by Graver Water Conditioning Co., 216 W. 14th St., New York 11, N. Y. Graver applies 5 to 7 coats of paint at installation time, using successively different colors for each coat. As the protective coating wears off, the operator can tell at a glance, from the color showing, just how much wear has occurred, how much protection remains, and which parts or sections have received more wear than others. Graver has found this system to be highly successful with its solids-contact unit, the Reactivator, used to treat brine for reflooding operations in the oil fields and also acid wastes from plating operations—both highly corrosive. This "rainbow" system has proven most effective also when used with Graver gravity filters and Graver chemical storage and feeding tanks.

New Figure 522 Tilter, specially designed for pouring from the rubber drums used for chemicals and solvents, is announced by Nutting Truck and Caster Co., 1201 W. Division St., Faribault, Minn. Easy to load, the filter saves time and effort, and, because of controlled pouring, eliminates spillage and waste. Of lifetime electrically welded construction, it is lightweight, portable, and requires little floor space. Non-slip clamp securely holds the drum. Standard Figure 522 fits the 13-gallon capacity drums (17¼" diameter by 20½" high), but can be furnished for other size drums.

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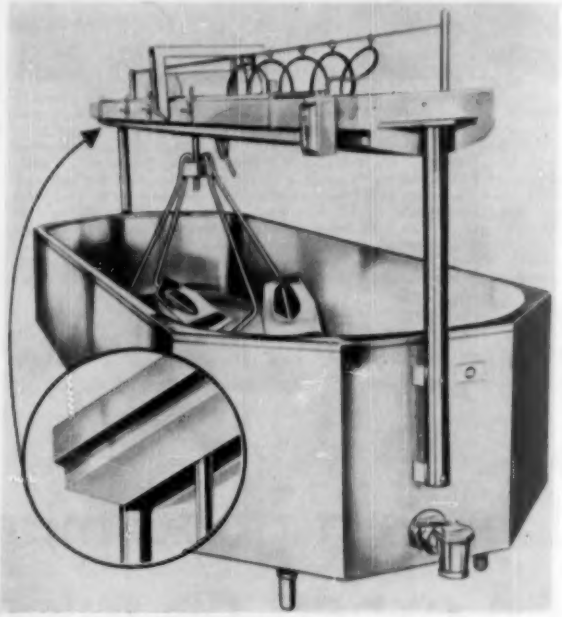

Of interest to cheesemakers and dairymen featuring cottage cheese is the new Kusel Model DL Forker and Agitator, designed and built by Kusel Dairy Equipment Co., Watertown, Wis. A "full skirted" protective housing around all moving parts assures that no foreign material can drop into the vat or its contents. Only the turning shaft projects through the skirt assembly. Also adding to the maximum sanitation features of the unit is the vat-supported "Center-Poised" end supports. The supports are seated in reinforced wells mounted on the vat itself, and are not in the way during operating hours or at clean-up time. Four styles of paddles may be attached to the agitator assembly. The "DL" is available in single carriage style, or may be installed in extra long vats with a twin or tandem carriage running the length of the vat. Hesitating action at end of each traverse guarantees that all curd in the vat receives uniform agitation from the paddles.

. . . the literary corner

Chemmuniqué, Vol. 3, No. 5, September-October 1955, mighty mite publication published by Atlas Powder Co., Wilmington 99, Del., relates the company's surprise in learning that glass bottle manufacturers were using such Atlas emulsifiers as Myrj 52-S polyoxyethylene stearate to cut down breakage. To quote from *Chemmuniqué*: " . . . As bottles jiggle along the conveyors and are handled in passing from one process to another, they rub together and scratch each other like cats in a free-for-all. After bottles have aged a bit, they lose this glass-to-glass scratchiness—apparently coated with a film of whatnot. But fresh glass is a different matter. The tiny scratches weaken the glass as much as 50%, and

there's the devil to pay in breakage unless something is done to protect the bottles against the ferocity of their fellow bottles." The article explains that the emulsifier is diluted down to something like a 0.02 to 0.1% solution, and sprayed on the bottles, forming an invisible waxy film that amounts to virtually zero in any kind of weighing or analysis, but nevertheless does its duty adequately.

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Aluminum pipe—for conveying everything from air to acid—is described in a new 18-page booklet published by Aluminum Company of America, 770 Alcoa Bldg., Pittsburgh 19, Pa. Entitled "Aluminum Pipe and Fittings," the booklet presents the product's characteristics and advantages for each of its major fields of application. Specifications are provided, along with a description of appraprate fittings and methods of installation.

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Taylor Technology, a crisp, slick-paper quarterly publication published by Taylor Instrument Companies, Rochester 1, N. Y., presents interesting accounts of the application of Taylor instruments to the specialized problems of various major industrial plants.

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Food manufacturers and processors and their contributions to today's better living were saluted in the recent "double anniversary" issue of *Valve World*, an external house organ published by Crane Co., 836 S. Michigan Ave., Chicago 5, Ill. The issue celebrates the 50th anniversary of the magazine and the 100th anniversary of Crane Co. Says the publication: "Food engineering is one of the fastest growing industrial sciences today. Advanced quality control techniques already are using in-stream analytical instruments. More and more, the control lab is being integrated with the production line. High-vacuum evaporation is providing the answer to moisture removal. Air conditioning is becoming standard equipment. Refrigeration is being made one of the basic steps in processing, and heat transfer is ending the pot-and-kettle era. Through these and many other phases of food engineering and processing, Crane valves, piping, and fittings are helping provide high productivity with low unit cost."

◆ ◆ ◆

New price list "L," published by BIO-RAD Laboratories, 800 Delaware St., Berkeley, Calif., shows availability for the first time of two new products: (1) Analytical Grade Chromatographic Alumina, and (2) Anion Exchange Resins which have been treated with an indicating dye to change color reversibly in going from the hydroxide to other ionic forms. In the Chromatographic Aluminas, neutral, acid, and basic types are shown in 3 mesh sizes. In the indicating types, 2 strongly basic resins containing quaternary ammonium groups are shown in 2 different mesh sizes. In addition, the price list includes current information on analytical grade Anion and Cation Exchange resins prepared by purification of commercial-grade Dowex resins.

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FOOD INDUSTRY TOPICS

Announcement of publication of the *1955 Revisions of the Official Methods of Analysis* has been made by the American Oil Chemists' Society, 35 E. Wacker Dr., Chicago 1, Ill. The set will be the largest in recent years, 156 pages.

◆ ◆ ◆

The Second Edition of the *Glossary of Packaging Terms . . . the Language of a Ten Billion Dollar Industry* is available from The Packaging Institute, Inc., 342 Madison Ave., New York 17, N. Y. The cloth-bound, hard cover, 6" by 9" book of over 250 pages of definitions contains roughly triple the number of terms in the First Edition (1948). Every effort has been made to assure the accuracy of definitions by checking with acknowledged authorities in specific areas of packaging. Single copies are $6.75. Quantity prices are: 5 to 9 copies, one shipment, one destination, $5.95 per copy; 10 or more copies, one shipment, one destination, $5 per copy.

◆ ◆ ◆

A new 88-page catalog just published by Koch Supplies, Inc., 2520 Holmes St., Kansas City 8, Mo., is the most comprehensive equipment catalog ever published by the firm. Catalog No. 80 lists many new items as well as modifications on old products, covering everything used in meat processing, from the holding pen to serving platter. A handy cross-reference index makes it easy to locate any item. Write for free copy.

◆ ◆ ◆

A 25-page booklet describing the properties and potentialities of the fat-derived non-ionic and cationic surfactants manufactured by Armour and Company is available from Armour Chemical Division, 1355 W. 31st St., Chicago 9, Ill.

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The romance of paper and paperboard, their almost endless roles in modern society, particularly in the food industry, and their power to lift living standards throughout the world are told in a new book, *Paper and Progress*, published by The Mead Corp., Dept. PP, Dayton 2, O. Related in pictures and brief text, the story ranges from paperboard bassinets for new-born babies, pallets for materials handling, Davy Crockett toys, and cigar boxes to business correspondence and magazines, cores for rolled linoleum, and containers for thousands of foods. Write for free copy on business letterhead.

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"Corn Starch," a 44-page booklet illustrated with photographs, drawings, and charts, is available from Corn Industries Research Foundation, Inc., 3 E. 45th St., New York 17, N. Y., and 1001 Connecticut Ave., N.W., Washington 6, D. C. The booklet discusses the nature of starch, how corn starch is made, the various types, and approved handling procedure. An appendix includes an analytical examination of corn starch. A simplified diagram shows the major steps of the corn-refining process. Photomicrographs and drawings illustrate the structure of various starch granules. The booklet is free, but distribution is limited.

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A new 132-page catalog of dairy and food processing equipment and supplies has been published by The Creamery Package Mfg. Co., 1243 W. Washington Blvd., Chicago 7, Ill. The catalog is designed as a complete buyer's guide to products ranging from ammonia accumulators to washing compounds, and is cross-indexed for easy reference. Some of the newest items in the field such as the latest CP "Milkeeper" Bulk Milk Tanks are included. Free copies available from the above address or from any of the firm's 22 branches.

◆ ◆ ◆

Two pieces of literature are served up by Mojonnier Bros. Co., 4601 W. Ohio St., Chicago 44, Ill. Smartly designed Bulletin 300 describes the Mojonnier Lo-Temp Evaporator all the way from the theory and economics of the unit to its applications and economies. "Mojonnier Food," a 20-page publication, presents an instructive series of articles on applications of Mojonnier processing equipment by various industries throughout the country.

. . . meeting hall and conference room

The Council of Participating Institutions of Argonne National Laboratory will sponsor a conference on the use of Isotopes in Agriculture January 12-14 at Michigan State University's Kellogg Center for Continuing Education, East Lansing, Mich. Coordinated with this, the American Assn. for the Advancement of Science and the Oak Ridge Institute of Nuclear Studies will sponsor a related conference on Atomic Energy and Agriculture at the Atlanta, Ga., meeting of the AAAS, December 26-30, 1955. At East Lansing, there will be intensive coverage of laboratory problems experimental problems, and results. The Atlanta session will develop the present status and future outlook for application of atomic energy in Agriculture.

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Scientists from at least 5 nations are expected to attend the 9th biennial conference of the American Society of Sugar Beet Technologists, to be held at the Mark Hopkins Hotel, San Francisco, Calif., January 31 through February 3, 1956. More than 140 technical papers will be presented, reporting on scientific advancements in sugar beet culture and beet sugar processing. Mr. J. Earl Coke, former U. S. assistant secretary of agriculture and now vice president of the Bank of America, will deliver the keynote address. For meeting information, contact Western Sugar Beet Producers, Inc., 461 Market St., San Francisco 5, Calif.

. . . building up and branching out

Bullard Sales Co., Inc., 214 Ponce de Leon Ave., N.E., Atlanta, Ga., has been appointed representative for Huron Milling Co., 9 Park Pl., New York 7, it was announced by Mr. H. Peale Haldt, Huron's food products manager. Bullard will handle Huron's food flavor enhancing product—monosodium glutamate—and Huron's hydrolyzed vegetable protein seasonings in Georgia. The firm will service food manufacturers and food processors, with special emphasis on the food specialty business, canning industry, and meat packing trade.

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The Chemical Division of Celanese Corporation of America, 180 Madison Ave., New York 16, N. Y., has opened a new storage terminal in Newark, N. J., as eastern distribution center for a broad list of liquid and dry chemicals produced by the company. One of the nation's largest facilities of its kind operated by an individual chemical company, the modern push-button terminal has initial capacities of 4,000,000 gallons of liquid chemicals, 1,000,000 pounds of dry products and, in addition, a substantial drumming capacity.

◆ ◆ ◆

Mr. E. F. Whitman, manager of the Stop and Shop Supermarket, Appleton St., Lowell, Mass., has won the $1000 grand prize in Continental Can's contest on promoting the economy of canned foods. In his entry, Mr. Whitman stressed the theme, "In Cans

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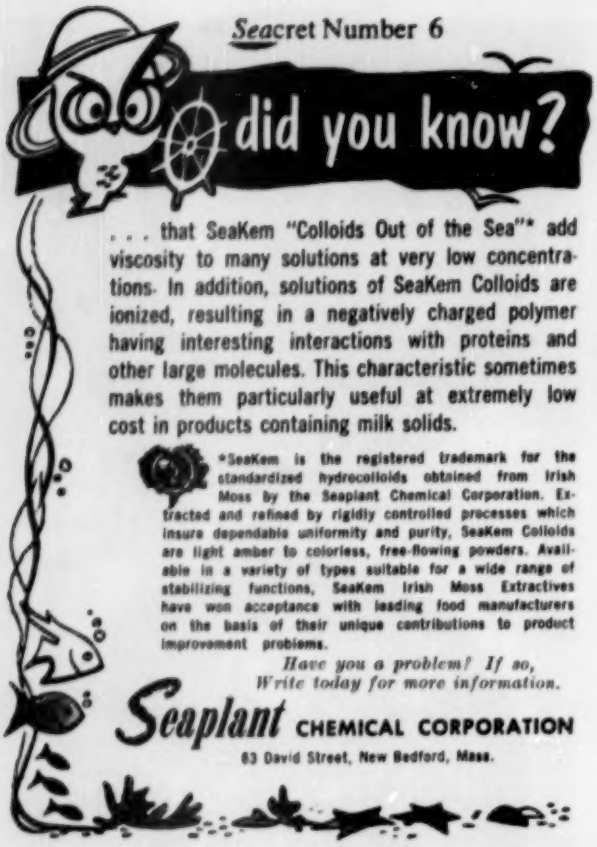
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FOOD INDUSTRY TOPICS

You Only Buy What You Can Use." In his market, he recommends the 8-ounce buffet can when eating alone, the No. 303 can for small families, and the large No. 2½ or 46-ounce can for feeding a large group. The $500 second prize winner in Continental's contest was Mr. Dan McCormick, owner of "Dan McCormick's" in St. Paul, No. Carolina. These, and 30 other winners of $1000 in cash prizes, were selected by editors of grocery trade publications.

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Plans for the company's future, as well as new product developments and increased promotional efforts were revealed by Barry Controls, Inc., Watertown, Mass., shock and vibration isolation equipment manufacturers. In line with the firm's organized campaign to intensify its diversification program, Barry recently acquired Insco Company, a producer of electro-mechanical instruments and controls. The instrument maker wishes to diversify further, according to Mr. Ervin Pietz, president, by acquiring products or concerns having products which are technical specialties sold to industry.

◆ ◆ ◆

Dewey and Almy Chemical Co., division of W. R. Grace & Co., 62 Whittemore Ave., Cambridge 40, Mass., is offering a 14-minute, color, sound film on the vacuum-packaging of meats, poultry, and dairy products. Entitled "As Good As It Looks," the film tells about Cryovac, the D&A shrinkable plastic bag used for packaging many perishable foods. The story is narrated from a consumer angle, using a store manager as its central figure. Mostly non-technical, the movie does take one short trip into the laboratory for scientific background. Available to packagers and processors, home economists, clubs, etc., free of charge, the film may be obtained by writing the firm's Cryovac sales promotion manager.

◆ ◆ ◆

. . . Ekco-Alcoa's Mitchell.

Formation of a new company which will manufacture and sell aluminum foil containers has been announced by Aluminum Company of America and Ekco Products Co. The new company, which will be owned jointly by Ekco and Alcoa, will be known as Ekco-Alcoa Containers, Inc., and will have its headquarters in Cook County near Wheeling, Ill. It will make aluminum foil containers for many products, especially in the baking, frozen food, and dairy industries. A new $5,000,000 plant enclosing an area of 165,000 square feet is under construction. Expected to begin operations early in 1956, it will employ approximately 100 workers. Mr. John M. Mitchell, recently manager of Alcoa's Export Division and Commercial Research Division, has been elected president and general manager of the new company. The firm reportedly was formed because of the rapid acceptance of aluminum foil as a material in the production of food containers.

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A new $1,500,000 research, development, and headquarters building, "dedicated to the American housewife," will be constructed at Towson, Md., by Crown Cork & Seal Co., Inc., Baltimore, according to Mr. Russell Gowans, president. The combination two- and three-story structure, fourth major expansion of Crown facilities within a year, will contain chemical, metallurgical, physics, and analytical laboratories; design and drafting departments; a technical library, and experimental machine shop. Experiments with new types of closures will begin as soon as the building is completed, late in 1956. Actual construction will begin in February.

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Gunnell Capsulations, Inc., Fraser, Mich., announces its reorganization as General Capsule Corporation (Delaware) with Mr. Andrew S. Mihalik remaining as president, assisted by an enlarged board of directors. The firm's newest development is the only instantly rupturing and completely soluble filled gelatin capsule. This reportedly has solved the oxidation problem in processing flavors and spices for manufacturers of mixes, fillings, puddings, etc. For use of the homemaker, packages of capsulated flavors and spices are expected to replace the more perishable

bottles of liquid flavors, eliminating measuring, evaporation, and spilling.

. . . the human element

Fritzsche Brothers, Inc., New York City, announces appointment of **Mr. James Shumaker** as manager of the firm's Philadelphia branch at 12 S. 12th St., replacing **Mr. Warren R. Godfrey,** recently transferred to New York headquarters to assume charge of perfume sales. Until his new assignment, Mr. Shumaker had managed Fritzsche's Cleveland office, which now will be closed and most of its accounts transferred to the Cincinnati branch for future handling.

Fritzsche also announces issuance of its latest price list—available to firms whose purchases are in wholesale quantities.

◆ ◆ ◆

Mr. John S. Beckett has resigned from his position as technical director for Aseptic Thermo Indicator Co., 11471 Vanowen St., No. Hollywood, Calif., to take up active work as secretary with the Thomas Aquinas Institute of Los Angeles, an educational organization within the Dominican Order. **Mr. Vincent A. Romito** and **Mr. Phillip K. Russoff,** research chemist and assistant research chemist, respectively, move up into the positions of technical director and research chemist. Mr. Beckett will continue to act as chairman of the Southern California Section of IFT, and chairman of the Task Group investigating critical storage temperatures of frozen foods for the Quartermaster Food and Container Institute, until replacements are appointed. He also will continue for a time to act in a consulting capacity for Aseptic Thermo Indicator Co.

◆ ◆ ◆

On the occasion of their recent visit to Europe, **Mr. Percy C. Magnus,** president, and **Dr. Henri F. Logcher,** export manager, Magnus, Mabee & Reynard, Inc., international essential oil firm with headquarters in New York City, were honored by executives of Cornehls & Bosse, of Hamburg, Germany, at a dinner at the Cosmopolitan Club, September 10. Mr. Herbert Cornehls and his associates congratulated MM&R on its remarkable growth and achievements since 1895, and expressed confidence in the future expansion of the firm's activities.

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Mr. J. L. Weisman, director of the Foreign Division of Felton Chemical Co., Inc., Brooklyn, N. Y., returned recently from a 7-week tour of Europe during which he visited the Felton plant in Versaille, France, and called upon Felton representatives in Germany, Switzerland, Austria, Greece, and Italy.

◆ ◆ ◆

Mr. C. L. Peterson has been appointed vice president and general manager of Brown Instruments Division, Minneapolis-Honeywell Regulator Co., Philadelphia, it was announced recently by Mr. Henry F. Dever, president. A 28-year man with the firm, Mr. Peterson had been a regional manager for Honeywell and general sales manager of the Brown Instruments Division, until his appointment in 1954 as divisional vice president. He will be responsible for the direction and coordination of operations in all departments of the Division.

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FOOD INDUSTRY TOPICS

Mr. Robert B. Schnering, president, Curtiss Candy Co., Chicago, has accepted chairmanship of the Confectionery Industry Promotion Committee, according to Mr. Philip P. Gott, president, National Confectioners' Assn., 221 N. LaSalle St., Chicago. The committee, which will be composed of candy manufacturers from the candy production centers in the U. S., will tackle the task of determining what type of program is suitable for the candy industry and what methods shall be used to finance it. Members of the committee will be announced shortly.

◆ ◆ ◆

Cochran Foil Co., 1430 S. 13th St., Louisville, Ky., has appointed **Mr. Frederick L. Stout, Jr.,** as manager of industrial relations. Before joining Cochran, he was in personnel and industrial relations with Pittsburgh Plate Glass Company and Dravo Company, Pittsburgh. In his new position, Mr. Stout will be concerned with the industrial relations activities of the increased plant facilities of all Divisions of the firm. The company also announces the appointment of **Mr. R. D. Vickers** as manager of New York District for the sales of the Foil Rolling Division and the Laminating Division.

◆ ◆ ◆

Two Rheem Manufacturing Company vice presidents received new management appointments recently when the firm's directors named **Mr. G. M. Greenwood** as chief financial officer, and **Mr. Gordon Mallatratt** as secretary and treasurer of the corporation. Mr. Mallatratt, who succeeds Mr. Greenwood as secretary and treasurer, has been general manager of the Rheem Products Division. He is succeeded by **Mr. Vearl J. Heinis,** general sales manager for Rheem Products Division. The appointments were announced by Mr. R. S. Rheem, company president.

In a related announcement, Mr. Rheem told of the election of **Mr. Angus Lightfoot-Walker,** vice president in charge of Rheem International, as a director of Rheem Manufacturing Company.

◆ ◆ ◆

Mr. Geo. E. Holm, special assistant to the chief of the U. S. Department of Agriculture's Eastern Utilization Research Branch, and former head of the Dairy Products Research Laboratories, retired from the Department on September 1. His research activities were in the biochemistry of fats, proteins, and colloids; hydrolysis and analysis of proteins; chemistry of the spoilage of fats and oils; heat coagulation of milk proteins; phospholipids in milk; manufacture of dried milk and butteroil; deterioration of butter; and the chemistry of milk and milk products. He was the third recipient of the Borden Award conferred by the

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ACS in 1942. In 1948, he received the Superior Service Award of the Department of Agriculture.

. . . a promotion for J. H. Robertson of Arkell & Smiths

Mr. J. H. Robertson has been named treasurer and comptroller of Arkell & Smiths, manufacturers of multiwall and specialty bags, it was announced by Mr. S. S. Yates, president and board chairman. Mr. Robertson had been A&S comptroller since 1950. He will make his headquarters in Canajoharie, N. Y.

Dr. Walter R. Fetzer, chief chemist of Clinton Foods, Inc., Clinton, Iowa, was presented with the 1955 Iowa Medal of the American Chemical Society's Iowa Section at a banquet of the section in Iowa City on October 28. Acclaimed by fellow scientists throughout the world for his achievements in the chemistry of cereals, corn, and sugars, the medalist, an IFT member, has been awarded 9 U. S. patents, and 6 additional patents are pending. He also is author of over 30 scientific papers and publications. Dr. Fetzer has been active in ACS affairs for 35 years.

Appointment of **Mr. Wm. Channell** as chief chemist for Golden Citrus Juices, Inc., Fullerton, Calif., has been announced by Mr. P. S. Twombly, president. Mr. Channell recently has been associated with Minute Maid Corporation as West Coast quality control representative. Mr. Henry Weidl, presently chief chemist of Golden Citrus, and who has been on loan from Minute Maid Corp., is returning to Florida for reassignment within the Quality Control Department.

In a ceremony September 20 at the Southern Utilization Research Branch of the USDA, New Orleans, La., Secretary of Agriculture Ezra T. Benson presented a Department Superior Service Award plaque to a group of scientists on the Branch research staff. Members of the group were **Miss Dorothy C. Heinzelman, Dr. Ralph W. Planck, Frank G. Dollear, Frank C. Pack,** and **Robert T. O'Connor.** The award recognized their work in development of new and highly improved methods of analysis of vital importance to research on new and expanded uses for fats and oils.

Individual Superior Service Awards were announced for 5 other members of the Southern Utilization Research Branch staff: **Dr. A. M. Altschul, Dr. Evald L. Skau, Dr. F. H. Thurber, Walter A. Pons, Jr.,** and **C. A. Fort.**

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Studies on the physical properties of food products made from newer forms of milk and eggs.

Advantages of nonfat dried milk solids in the diet.

Relation of the age of milk products, either liquid or powder, to the nutritional value to the infant.

Researches on milk and its various constituents.

During the process of curing cheese, does any change in nutritional values take place? Is the shrinkage in weight of cheese, when it is one year old as compared to one day old, due to a moisture loss or a loss (or gain) of other properties? The effect of curing on the nutritional value of cheese.

The nutritive values of a lower fat provolone (cheese).

Nutritional value of dried milk in prepared mixes.

Nutritional value of dried egg in prepared mixes.

Evaluation of individual nutritional values in yeast.

The properties and classification on nonprotein nitrogen in yeast.

Data regarding the purine and cholesterol contents of foods in the American diet. The sodium content of foods.

Nutritional values of foods used largely by those of Spanish background.

Fundamental study of the chemistry of the basic raw materials of food ingredients, particularly the major raw materials of the food industry.

Chemical composition and physical properties of all types of foods.

Development of low cost milk substitutes for human consumption suitable for use in areas where kwashiorkor exists.

Nutritive value of food wastes (as plate scraps and other foods, thrown into the garbage can).

Adequate tables listing the content of calcium, magnesium, potassium, sodium, phosphorus, chloride, sulfur, protein, fat and carbohydrates in unprocessed and processed foods.

Comparison of nutrition laboratory results with those obtained under practical field conditions.

Blanching extraction of vitamins from whole and cut green beans.

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LOW IN CALORIES.
IT LOOKS GOOD, TASTES BETTER, SELLS BEST!

INSTANT DIETETIC CHOCOLATE PUDDING

Dietetic pudding mix for preparing instant-type puddings easily made with MARGEL, specially prepared algin stabilizer for low calorie cold milk puddings.

MARGEL	18.3%
FINE QUALITY DUTCH COCOA	55.2
CALCIUM GLUCONATE USP	12.8
TETRASODIUM PYROPHOSPHATE, ANHYD.	7.4
SALT	3.6
VANILLIN	0.7
SODIUM SUCARYL	1.5
SACCHARIN	0.5
	100.0%

DIRECTIONS Add a one ounce package of the above pudding mix to two cups of milk with stirring.

CALORIC VALUE

Caloric value of MARGEL is about 1.0 calories per gram. Pudding made with this mix and 2 cups of skim milk will provide 4 servings at 59 calories each or 6 servings at 39 calories each. Algin stabilizers reduce or replace starch and sugars, cut calorie content way down!

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ALGIN ADVANTAGES in your pastry, syrups, salad dressings and desserts

1) Gives desired viscosity and body.
2) Assures greater stability to emulsions.
3) Prevents separation.
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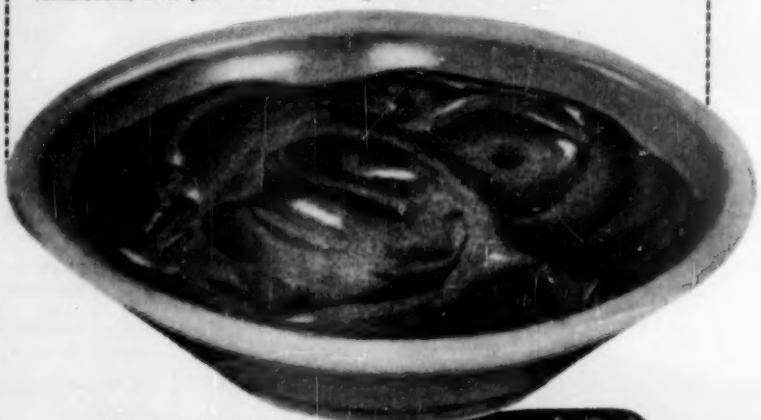
6) Easy to use in all kinds of dry mixes, dry blends, or paste type products.

For further information on the use of Kelco Algin products in dietetic food formulations, write your nearest Kelco regional office listed below.



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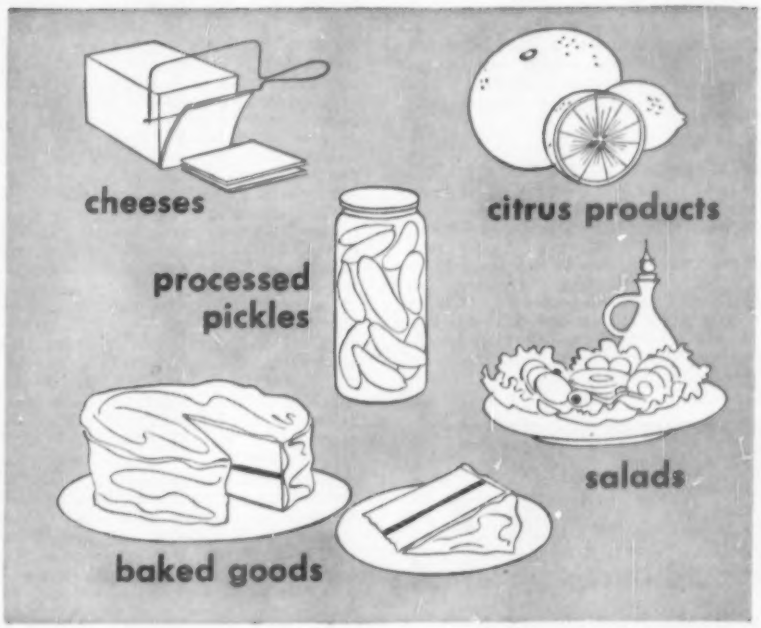

- Sorbic can be used with confidence at required levels—it is metabolized like fatty acids in foods.
- Sorbic controls growth of many undesirable microorganisms in foods.
- Sorbic can be so used that it permits the growth of many of the desirable organisms.
- Sorbic contributes no flavor at required concentrations in foods so far tested.

For further information write the CARBIDE office nearest you for technical bulletin F-6568. In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Montreal and Toronto.

* CARBIDE's *refined sorbic acid for use in foods.*

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Cause of the development of toxicity in butter clams and other shellfish in certain areas of the North Pacific Coast.

Excerpted from the SURVEY OF FOOD AND NUTRITION RESEARCH IN THE U. S. A., 1952-53, Food and Nutrition Board, National Research Council.

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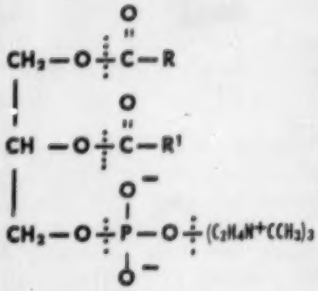

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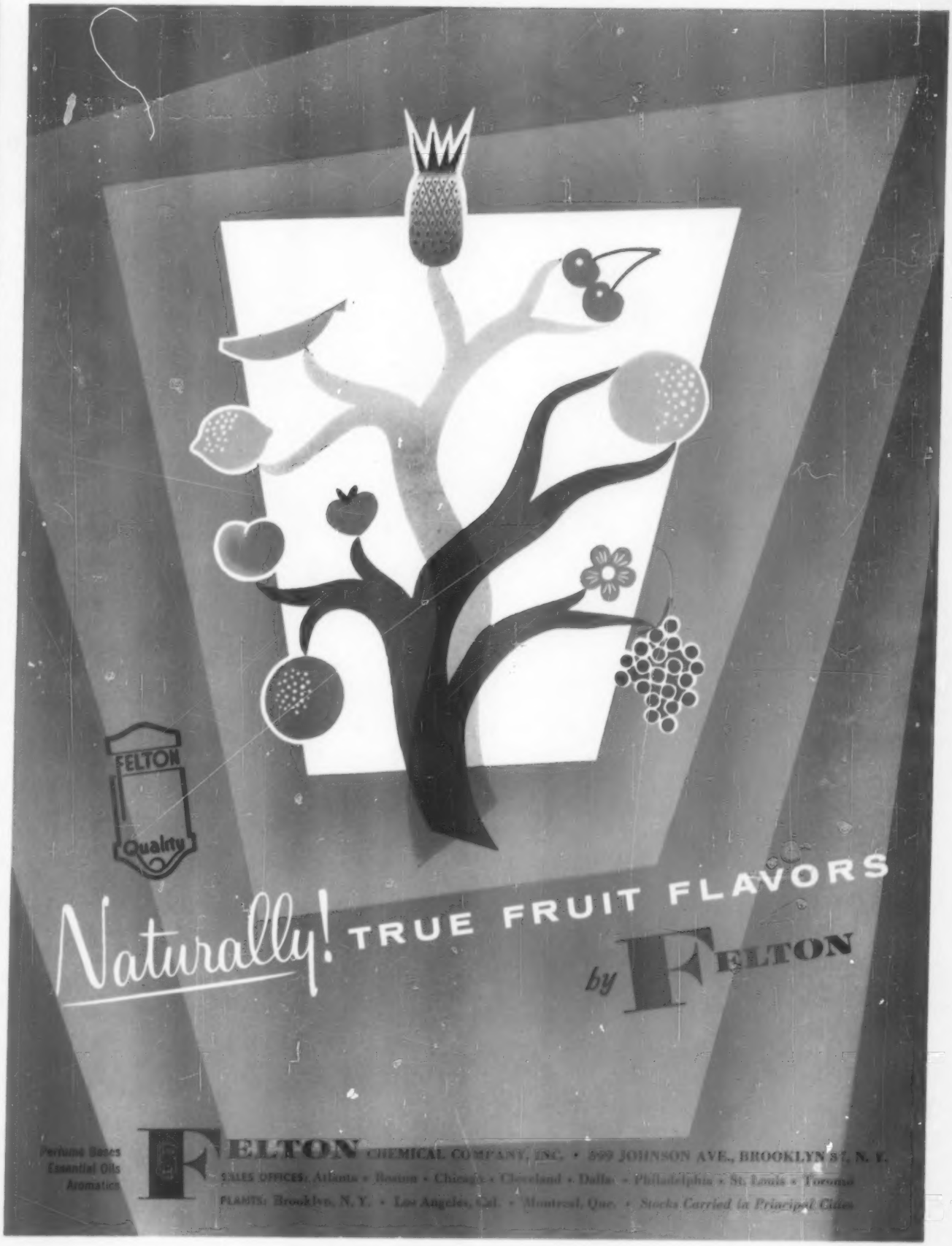
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